

MOTORCYCLE ENGINEERING

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- A **motorcycle** (**motorbike**, **bike**,) is a two or three-wheeled moto vehicle steered by a handlebar from a saddle-style seat, driven by an engine, with one seat for the driver and often a seat for a passenger behind the driver.



Types of Motorcycles



Standard



Cruiser



Chopper



Underbone



Moped



Touring



Motocross



Sport Bike

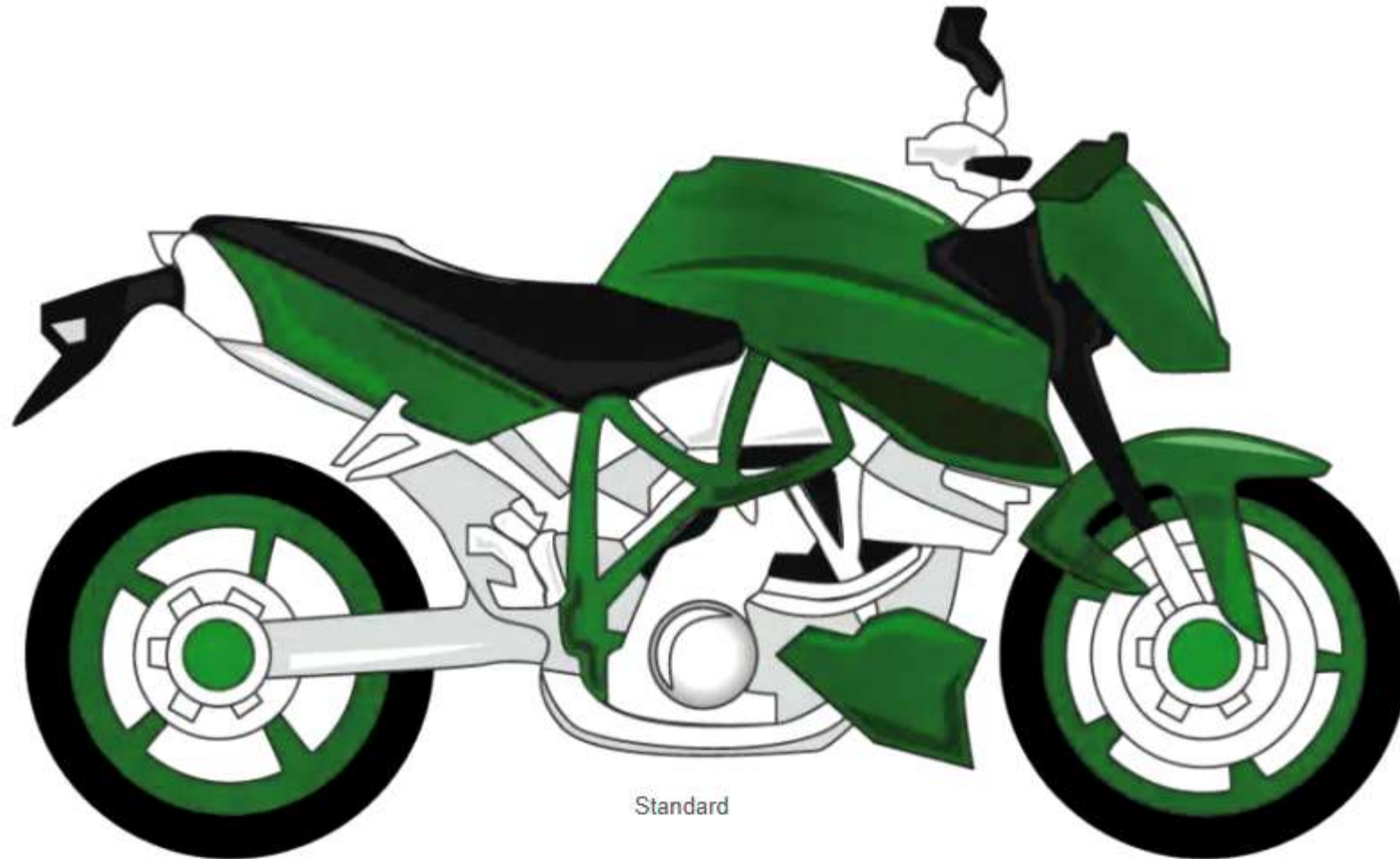


Scooter



Off-Road Bike

- **Standard** : The standard type of motorcycle is a common favorite because it has a simple design and is suited for all purposes. It has variations from 125cc up to 1,000cc and can be fitted with luggage, a tank bag, and a different seat, and it makes a good first and all-around motorcycle to ride. It doesn't normally come with a large fairing on the front if it has one at all.



Standard

Yamaha SR400



- Ergonomics are pretty neutral as it isn't very forward-leaning or rearward reclining. Seat height is usually in the shorter to middle range and can fit almost everyone.
- Standard Bikes are not too large for a beginner, yet not too small for an experienced rider

Ducati Monster 696



- **Cruiser** The cruiser, also nicknamed a chopper, was designed for cruising, hence, how it got its name. It typically has a little lower seat height, making it a good “cruising” around-town motorcycle, but with added luggage, it can make a good weekend rider. Again, the engine sizes vary from a small displacement engine to 1,000cc or more, depending on the brand.



Cruiser

Honda Rebel 500



Indian Scout





Harley Davidson Motorcycle

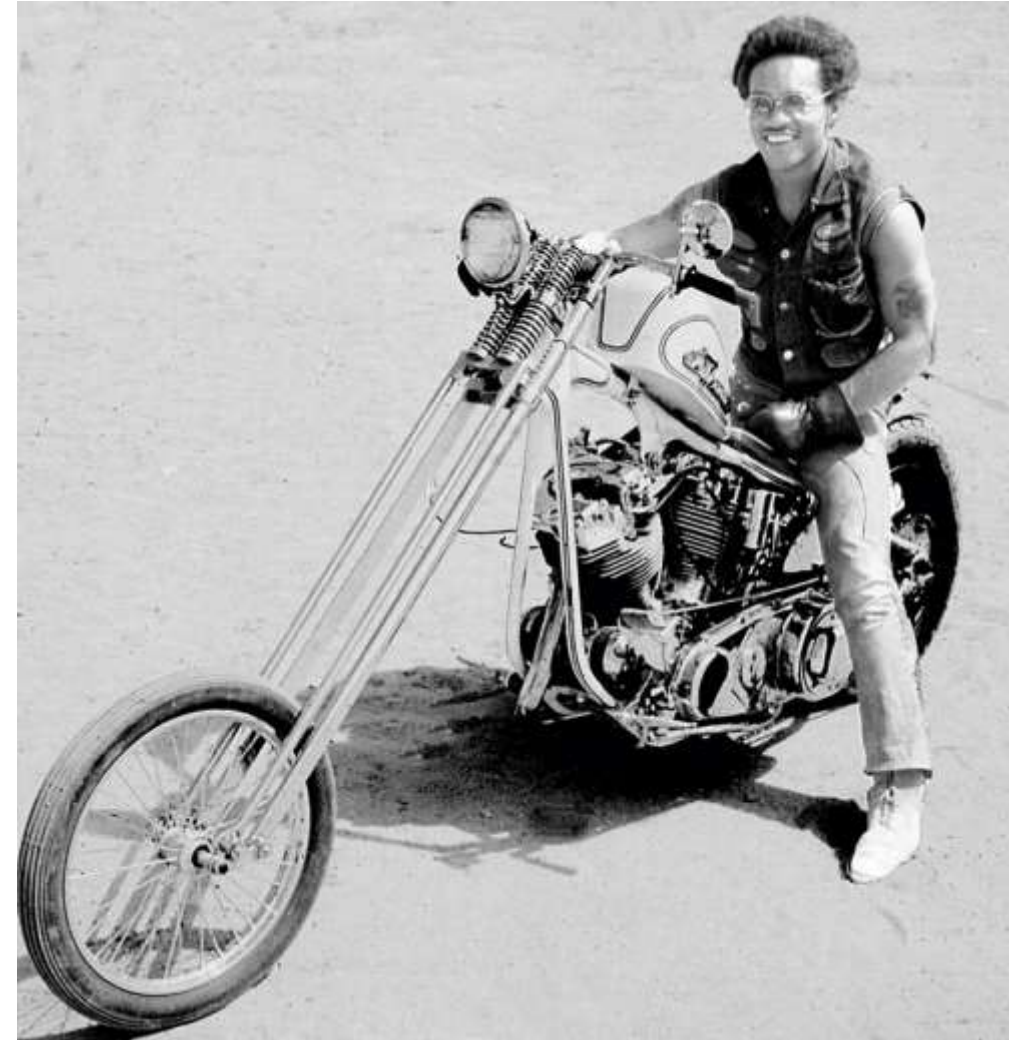


- Cruisers have limited cornering ability due to a lack of ground clearance



- A **chopper** is a type of custom motorcycle which emerged in the US state of California in the late 1950s. A chopper employs modified steering angles and lengthened forks for a stretched-out appearance. They can be built from an original motorcycle which is modified ("chopped") or built from scratch.

1970 Harley-Davidson
Chopper



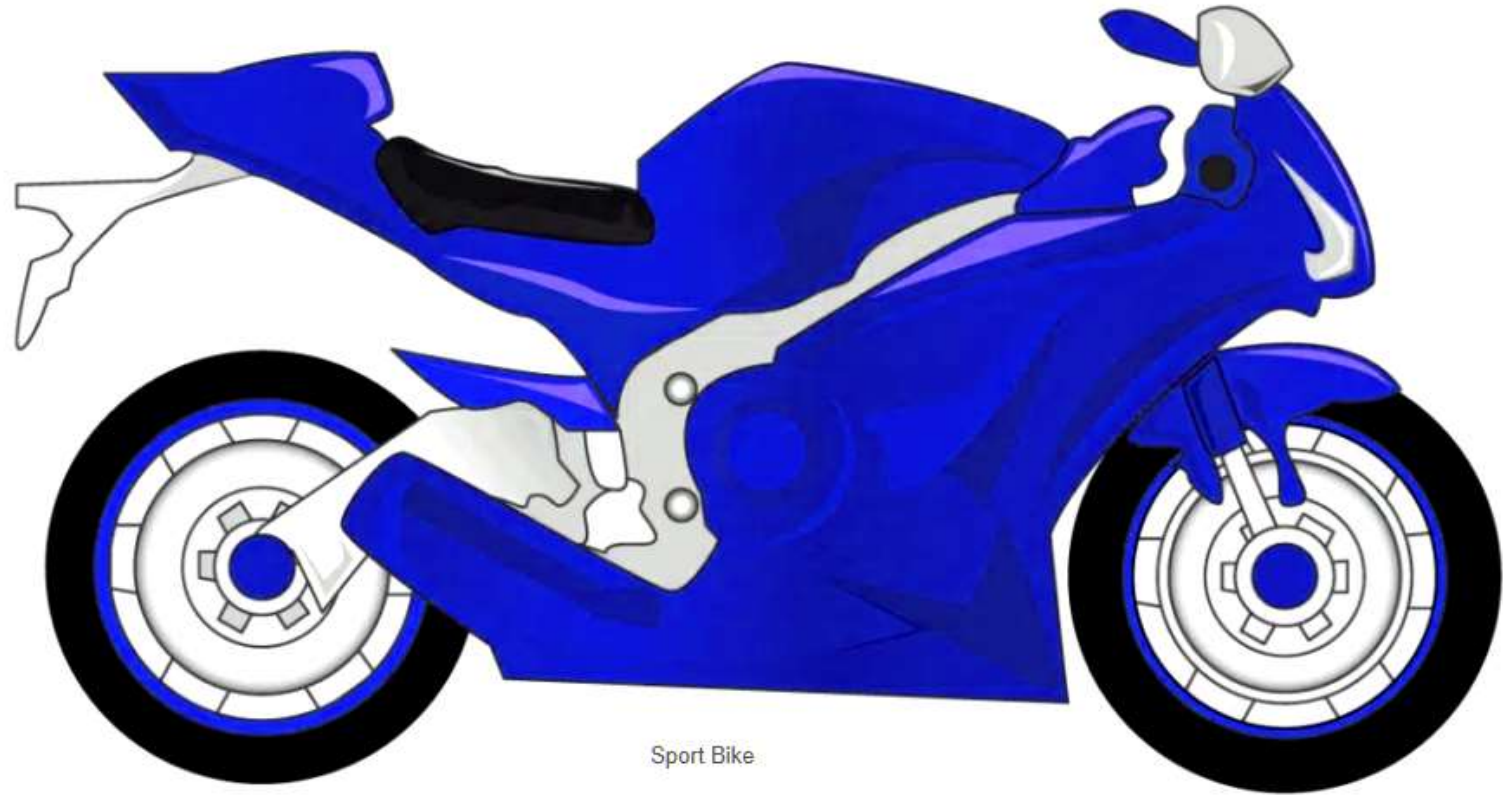
- **Touring** motorcycles are a class of motorcycle designed specifically for long-distance motorcycle trips. They generally feature large, powerful engines, cargo space or carriers for luggage, and an upright riding position.



**1998 Honda Goldwing
GL1500SE**



- A **sport bike** (**sports motorcycle**, or **sports bike**) is a motorcycle designed and optimized for speed, acceleration, braking, and cornering on asphalt concrete race tracks and roads. They are mainly designed for performance at the expense of comfort, fuel economy, safety, noise reduction and storage in comparison with other motorcycles









- **Off-road motorcycles**, or dirt bikes, are any motorized two-wheeled machines that are designed to be ridden in dirt, sand, mud, grass, or gravel

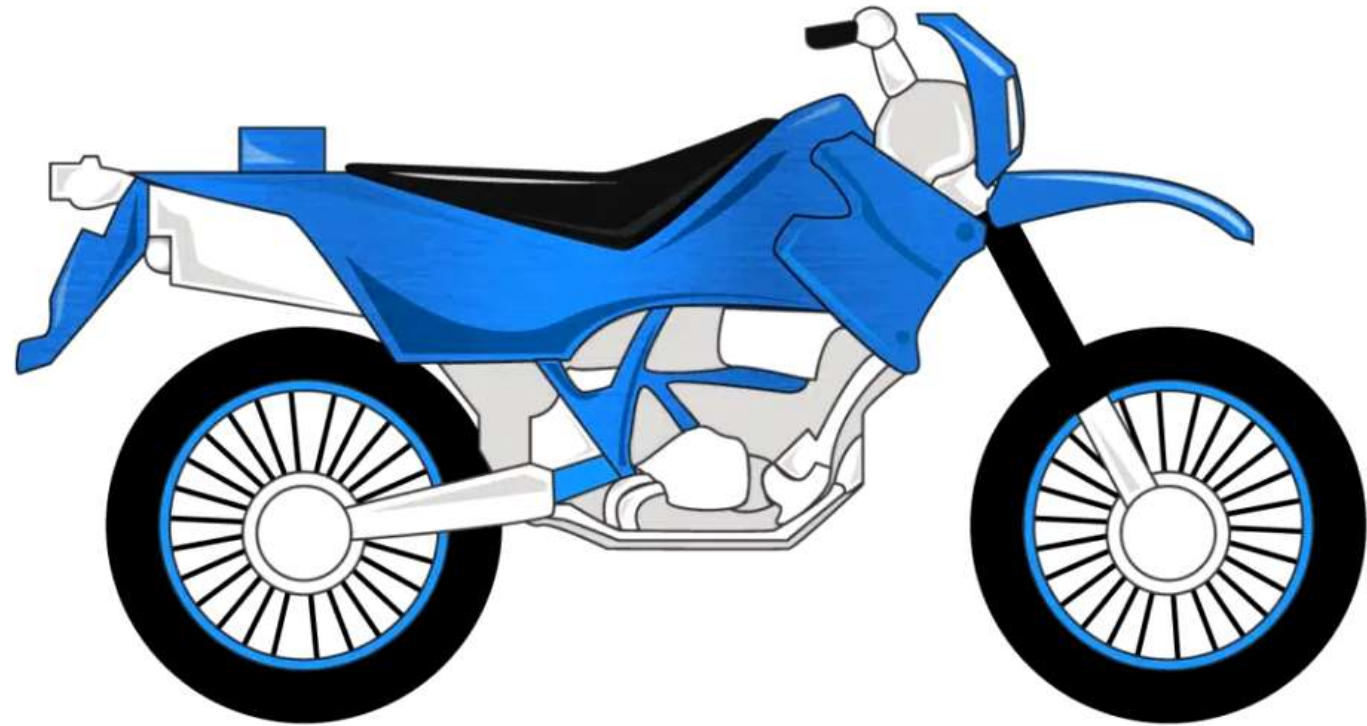




- **Off-road motorcycles** are normally equipped with an 18-inch rear wheel and 21-inch front wheel, softer suspension, a kickstand, and a large fuel tank. They sometimes have different transmissions, off-road-specific tires, skid plates, and hand guards in stock form too. Their counterparts, motocross bikes, feature stiffer suspension and a smaller gas tank in order to cut down on weight. typically having long suspension travel, high ground clearance,



- A **dual-purpose** motorcycle is a type of street-legal motorcycle that is designed for both on and off-road use. The terms ***all-road***, ***on/off road***, and ***dual-purpose*** are also used for this class of motorcycles. Dual-sports are equipped with street-legal equipment such as lights, speedometer, mirrors, horn, license plate mounting, and muffler and can, therefore, be registered and licensed





BMW R1200GS

- A **sport touring motorcycle** is a type of motorcycle that combines the performance of a sport bike with the long-distance capabilities and comfort of a touring motorcycle. They are usually taller in seat height than a Touring motorcycle and have better luggage options than the Sport motorcycles for hauling extra gear on longer trips.



BMW K1200GT



- A **scooter (motor scooter)** is a motorcycle with an underbone or step-through frame, a seat, a transmission that shifts without the operator having to operate a clutch lever, a platform for the rider's feet, and with a method of operation that emphasizes comfort and fuel economy.





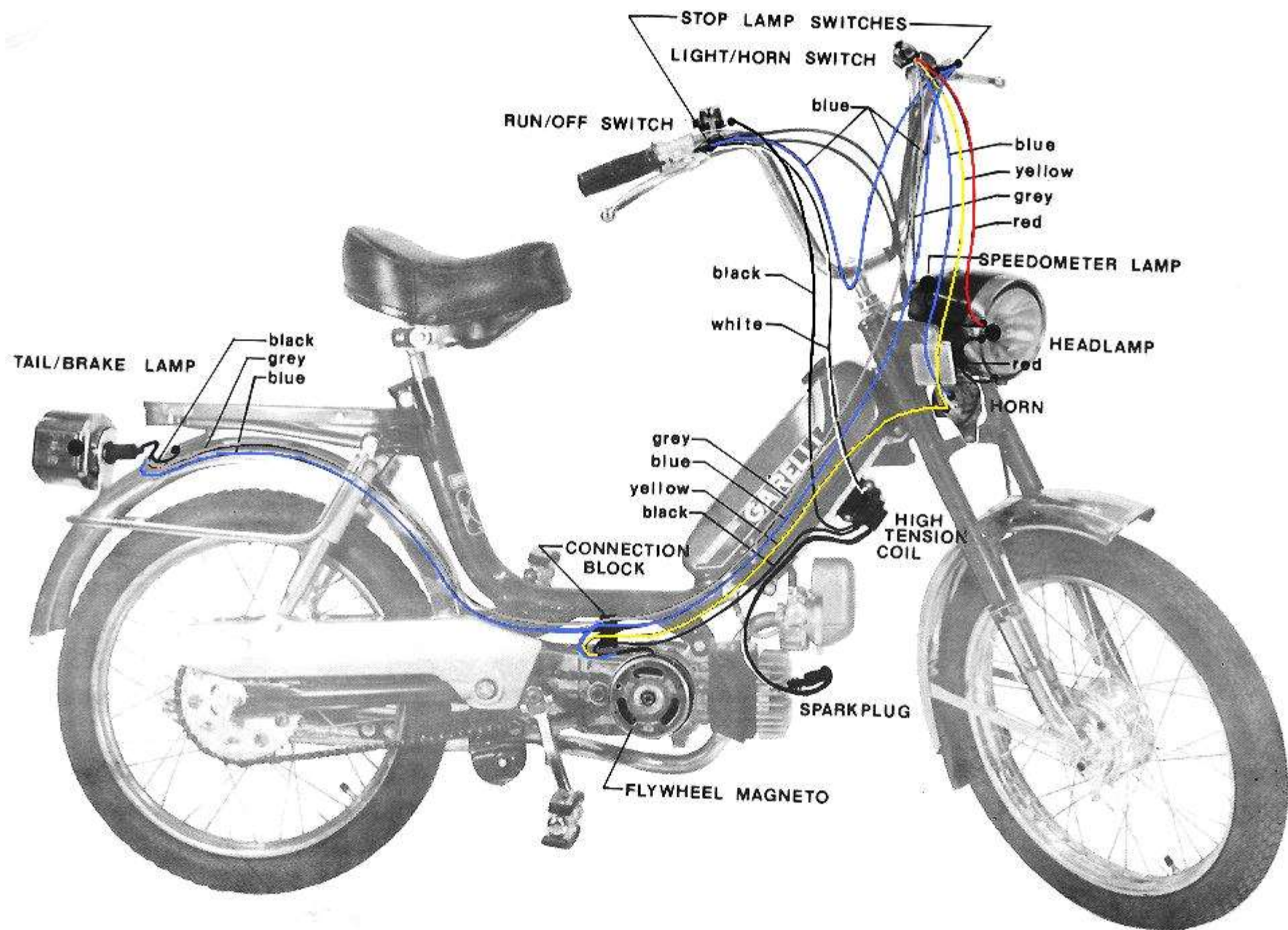


- An **underbone** is a type of motorcycle that uses structural tube framing with an overlay of plastic or non-structural body panels and contrasts with monocoque or unibody designs where pressed steel serves both as the vehicle's structure and bodywork.



- The **Moped** has a lighter frame than a scooter and it's based on a bicycle-style and a smaller engine (50cc or less) or even an electric motor in place of the engine. Mopeds typically travel only slightly faster than bicycles on public roads.

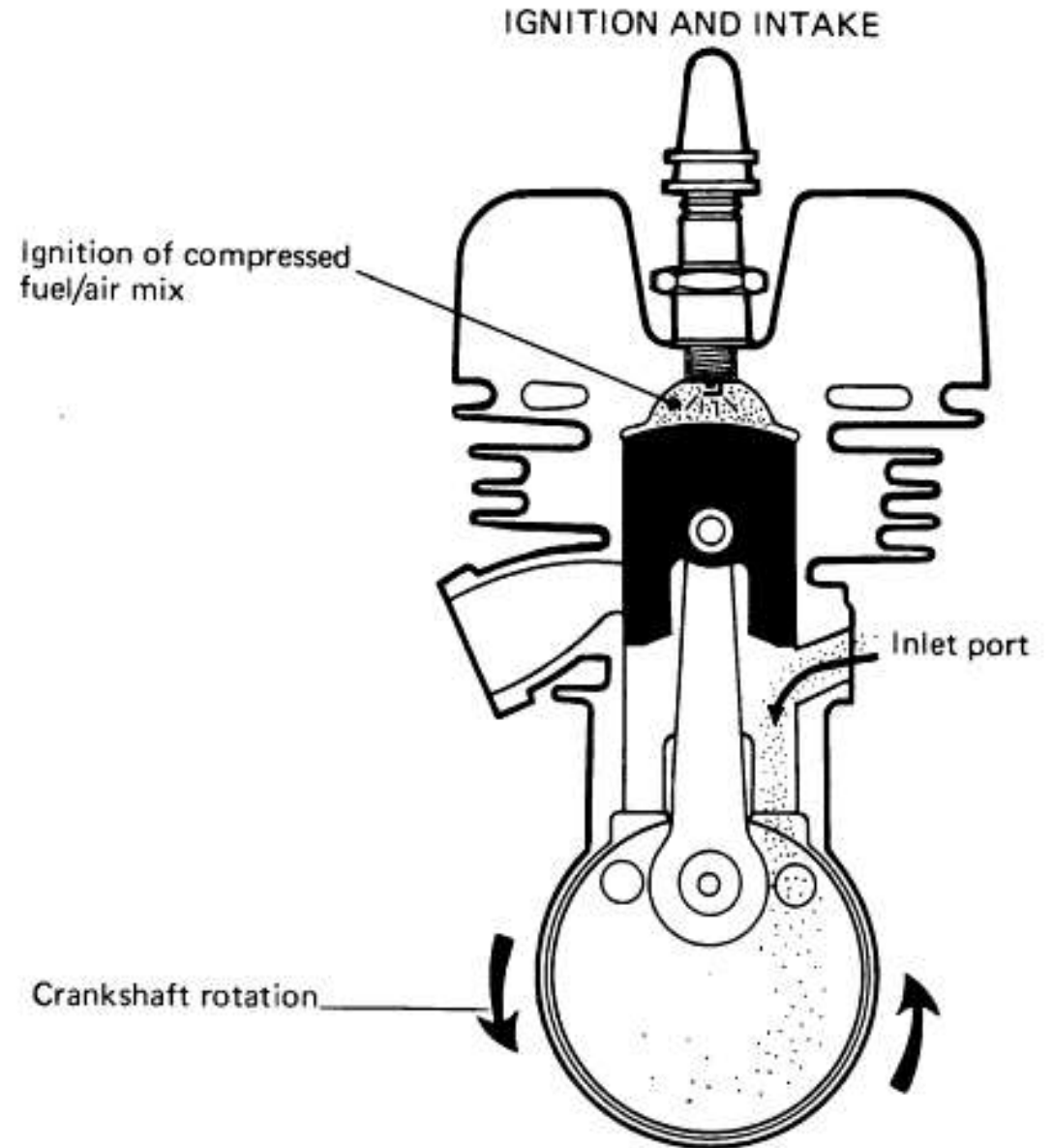


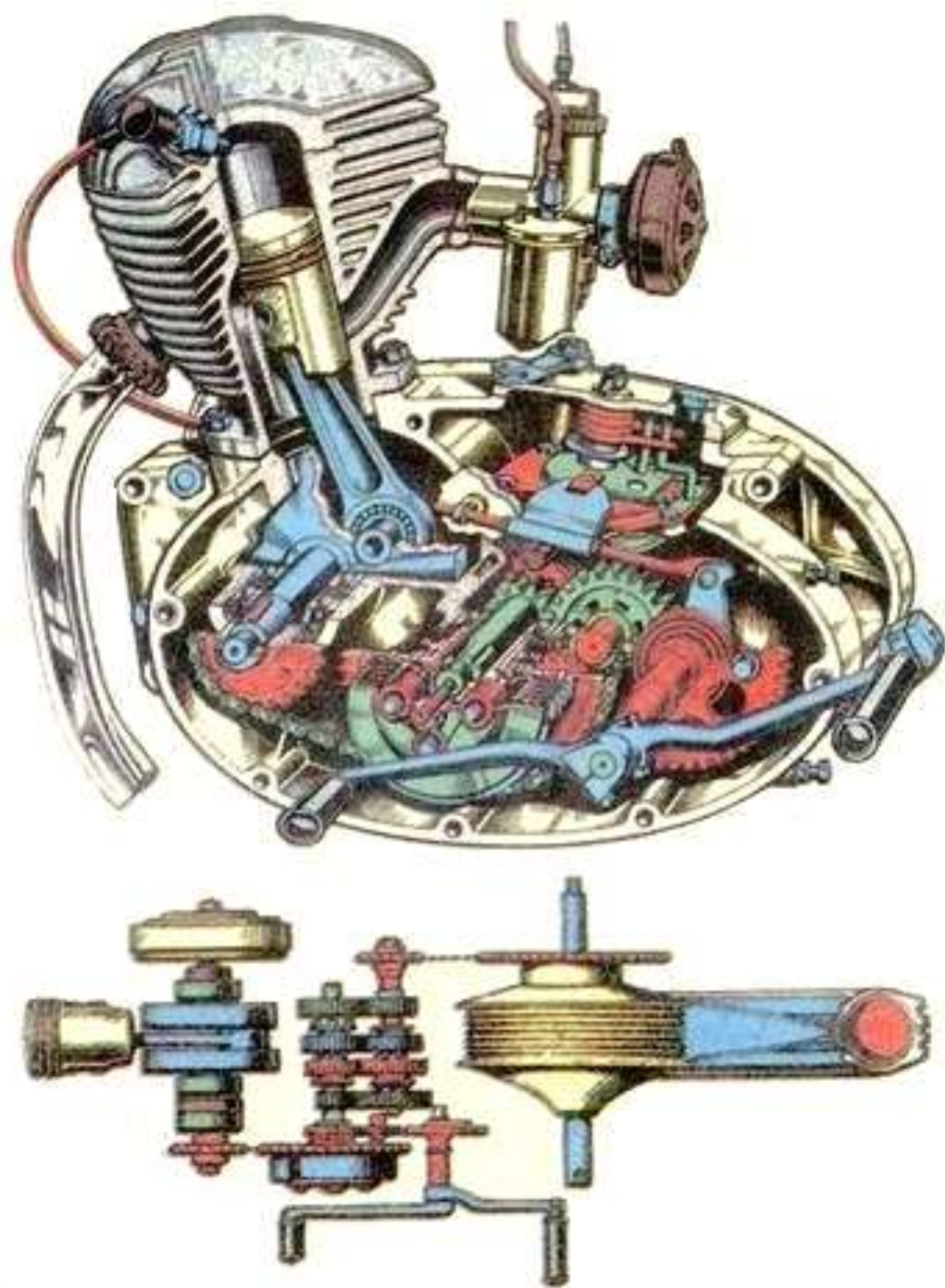
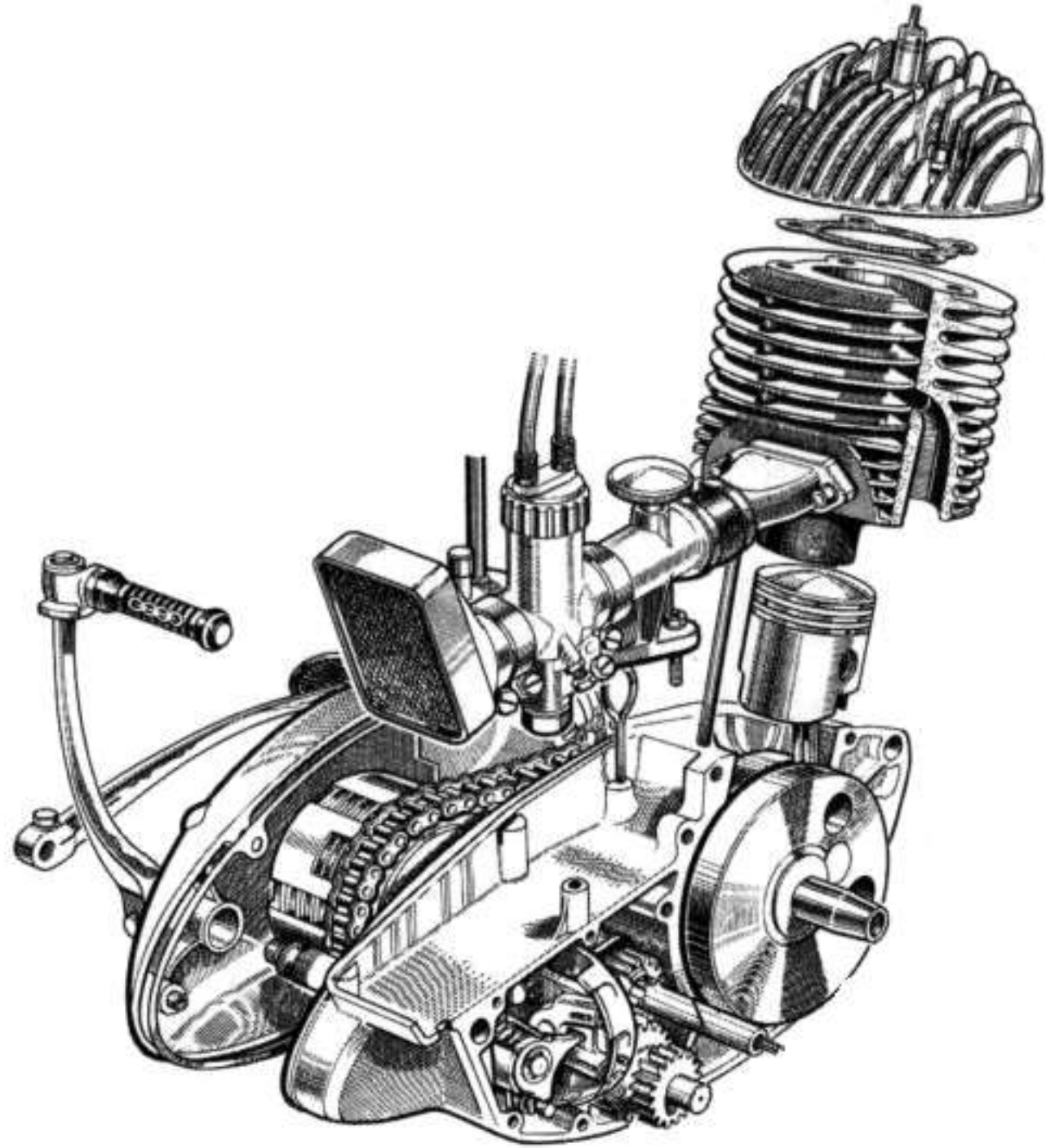


Two Stroke Engine Upper End

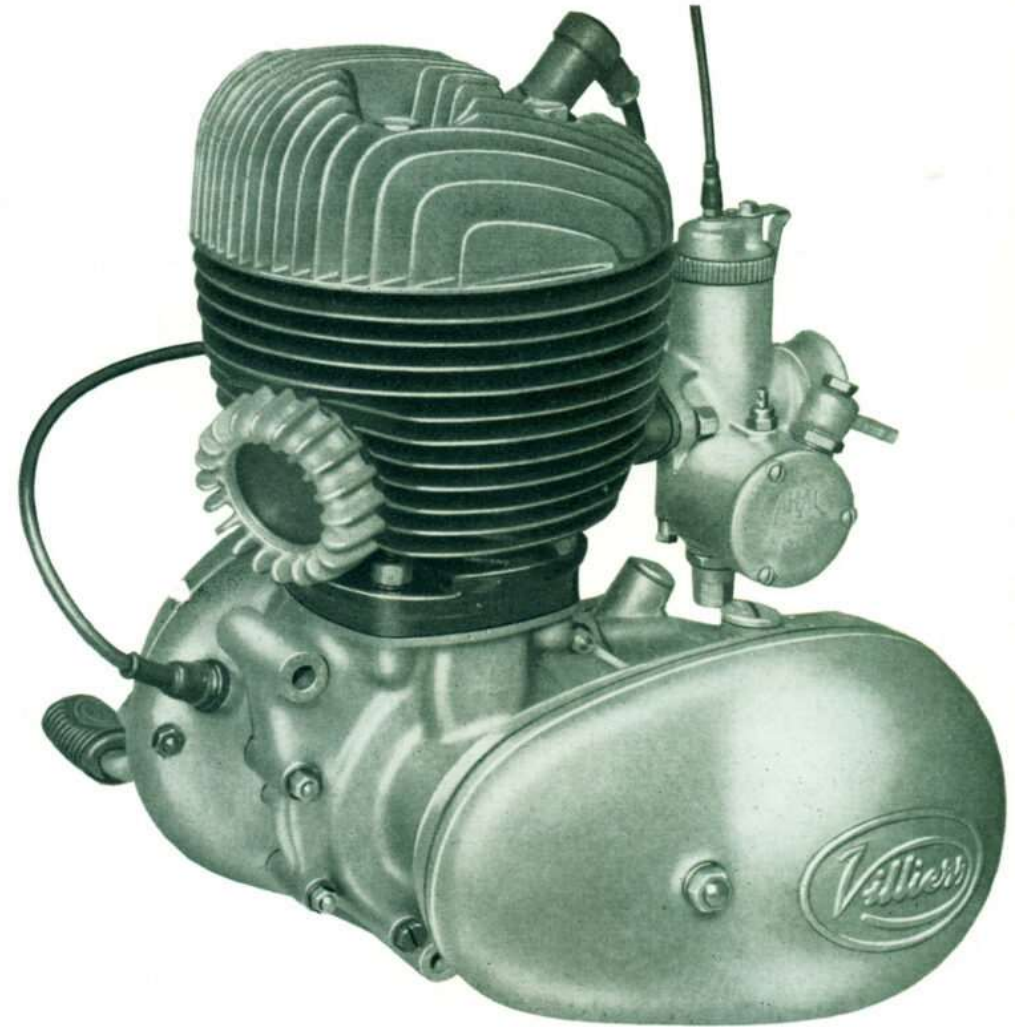
TWO STROKE ENGINE

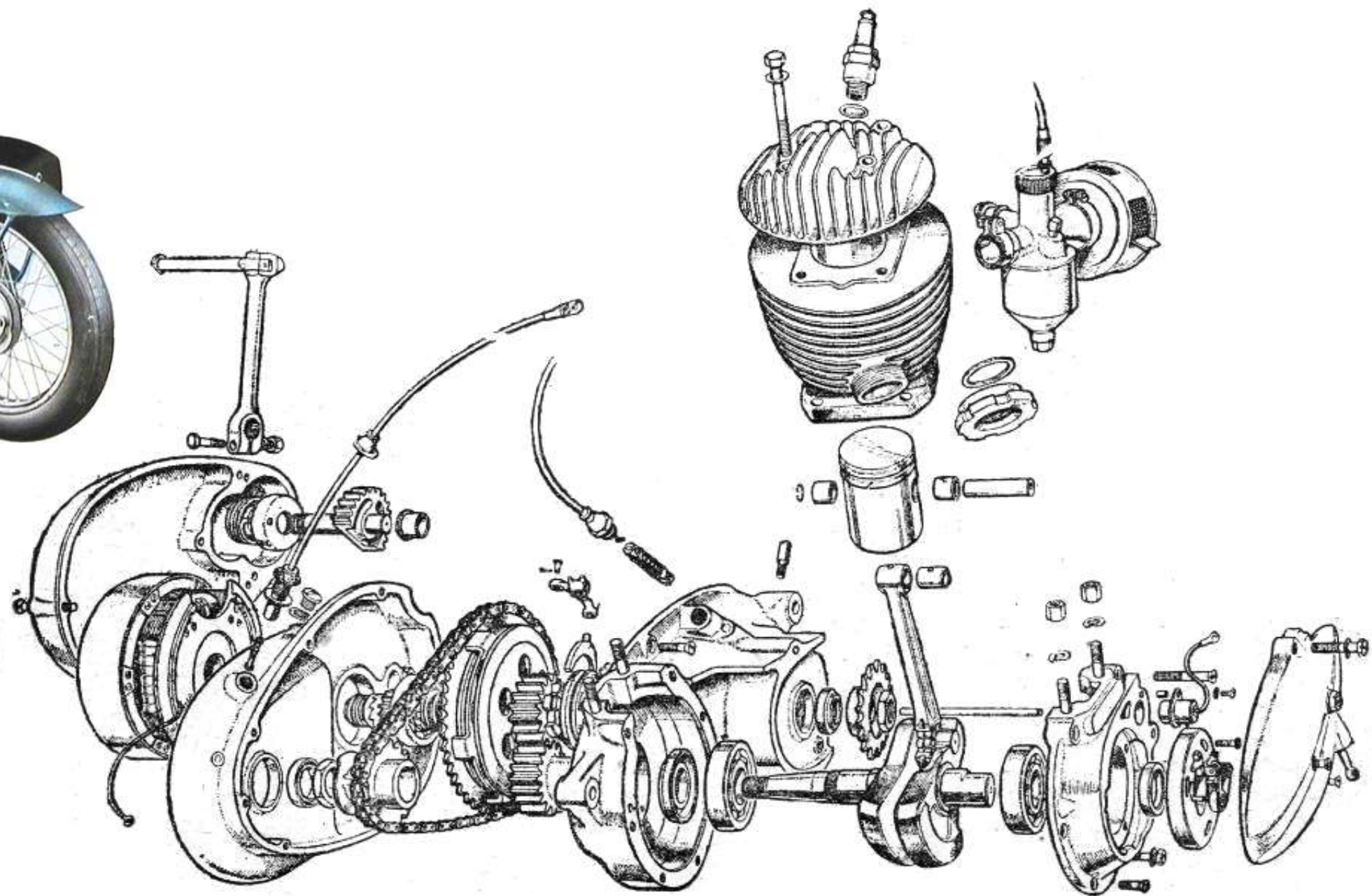
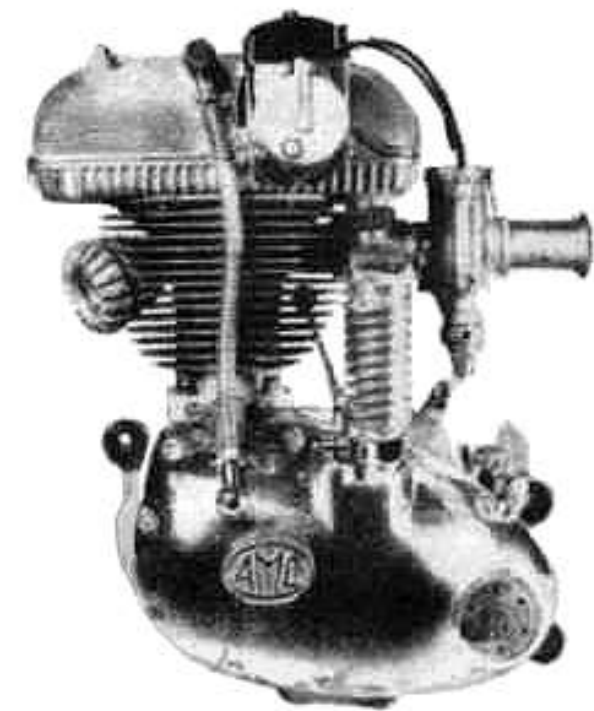
- A **two-stroke** (or **two-stroke cycle**) **engine** is a type of internal combustion engine that completes a power cycle with two strokes (up and down movements) of the piston during one power cycle, this power cycle being completed in one revolution of the crankshaft





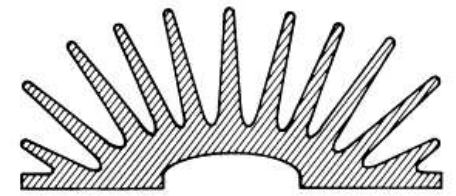
- Two-stroke engines have a simpler design and fewer moving parts than four-stroke engines, which makes them lighter, more compact, and less expensive to manufacture. It has more output power than the 4-stroke engine which completes a power cycle after the completion of four strokes of the piston or two revolutions of the crankshaft.



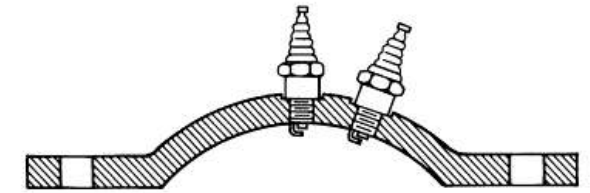


A **piston ring** is a metallic split ring that is attached to the outer diameter of a piston in an internal combustion engine and the main functions of piston rings in engines are:

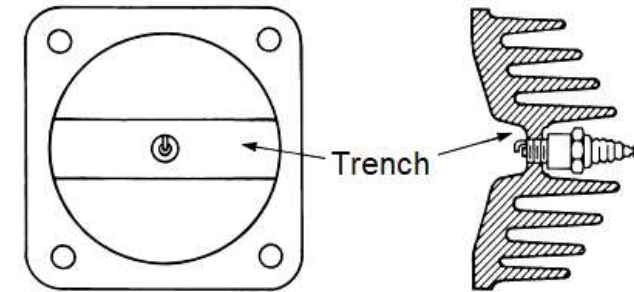
- Sealing the combustion chamber so that there is minimal loss of gases to the crank case.
- Improving heat transfer from the piston to the cylinder wall.
- Maintaining the proper quantity of the oil between the piston and the cylinder wall



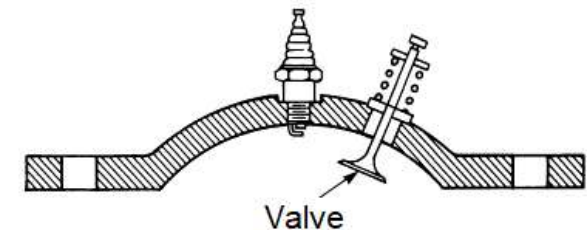
(a) SUNBURST HEAD



(c) TWO PLUG HEAD

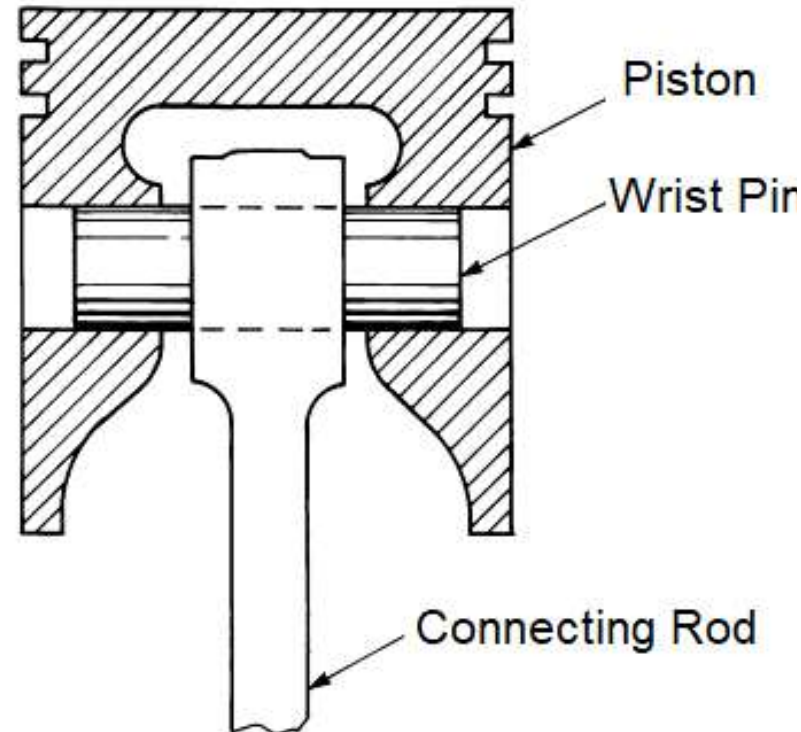


(b) TRENCH HEAD



(d) COMPRESSION RELEASE

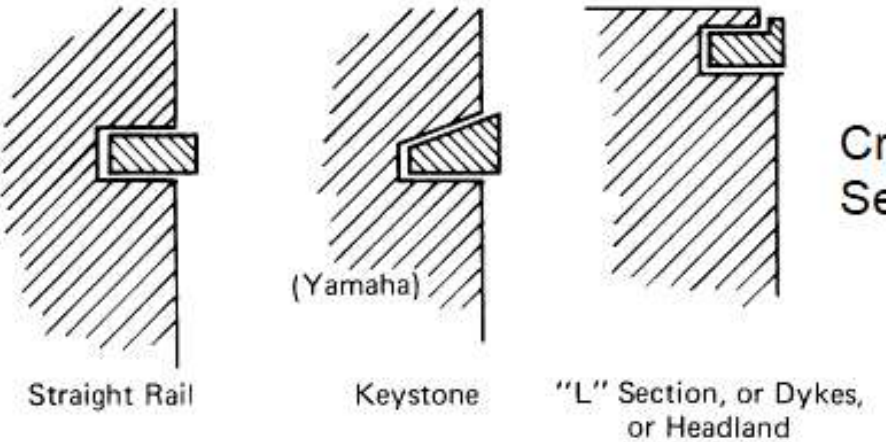
Cross
Section



Piston

Wrist Pin

Connecting Rod



Straight Rail

(Yamaha)

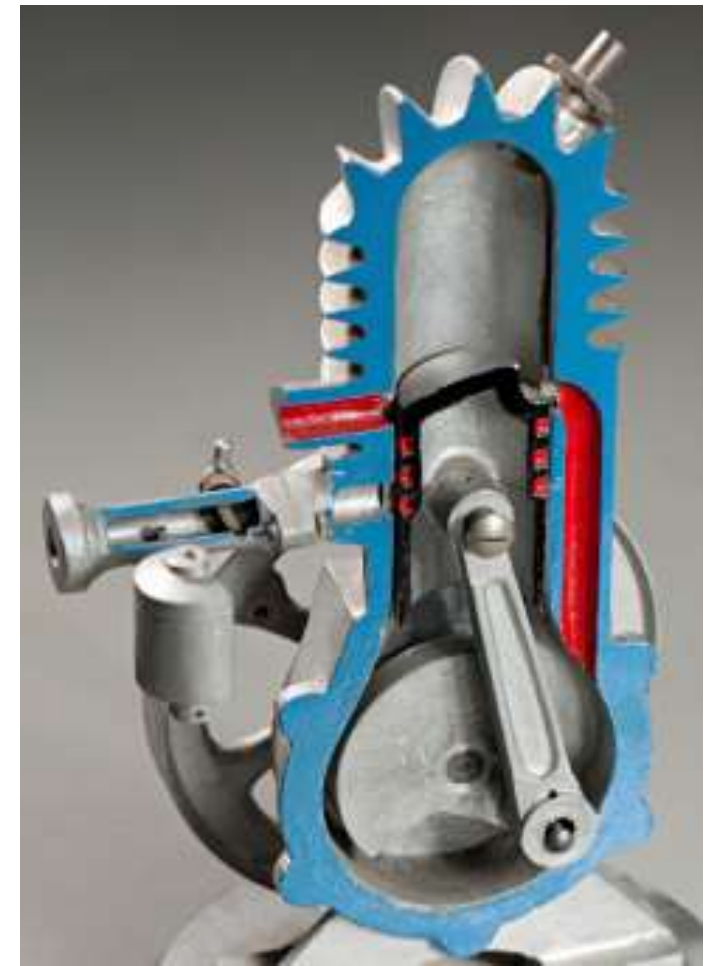
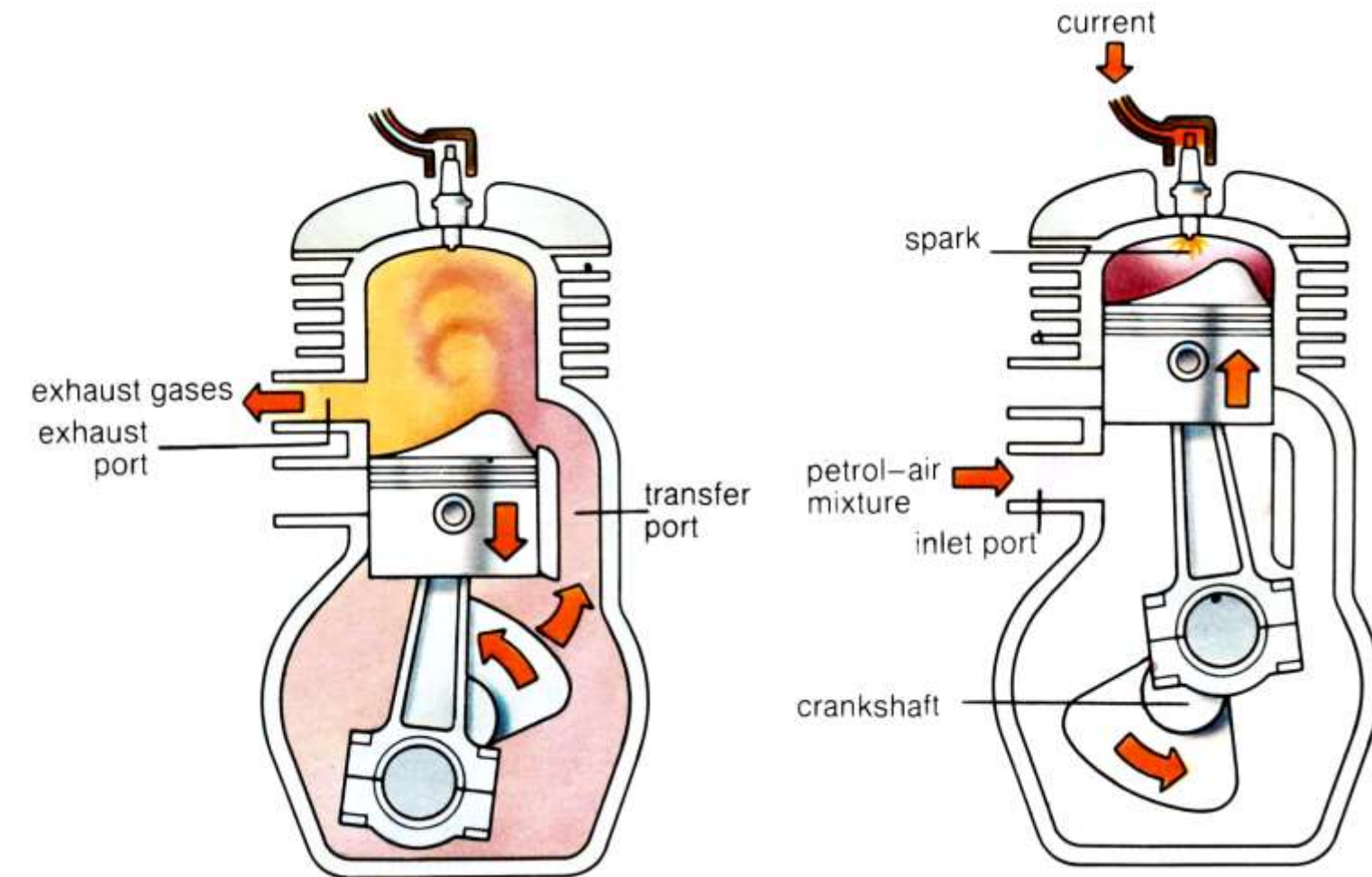
Keystone

"L" Section, or Dykes,
or Headland



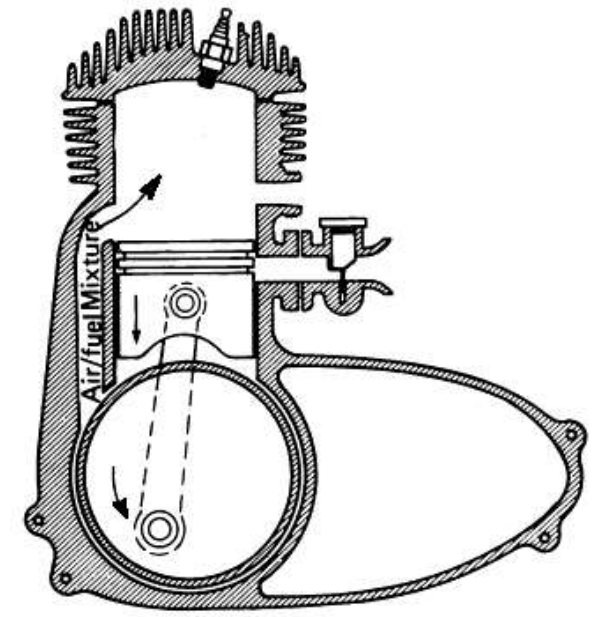
Two Stroke Piston Rings

- The 2-stroke petrol engine works on the otto cycle. In this engine, the intake, compression, power, and exhaust processes all occur within two strokes of the piston. These engines have higher emission rates than the 4-stroke petrol engine. They also need a proper supply of engine oil to the fuel mixture for lubricating the engine's moving parts, such as the piston, camshaft, and crankshaft

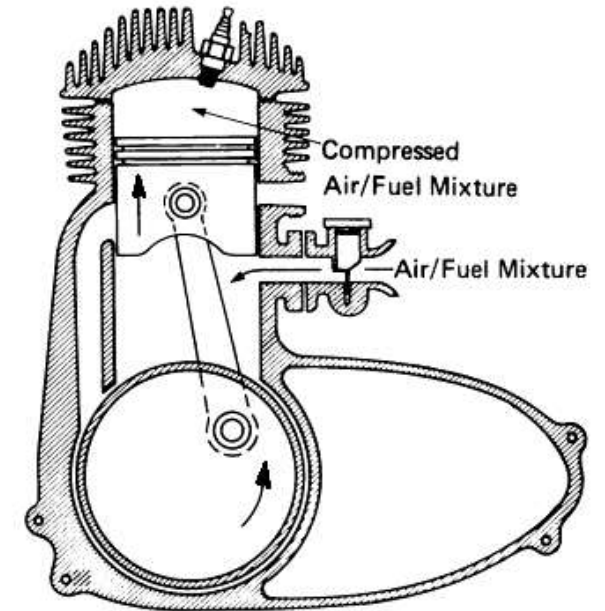


Suction and Compression Stroke

- In a 2-stroke engine, the suction and compression strokes take place simultaneously.
- During this stroke, the piston moves upward from the bottom dead center (BDC) to the top dead center (TDC).
- During this upward movement of the piston, a vacuum starts producing inside the compression cylinder (combustion chamber) of the engine. Due to the creation of this vacuum, the air-fuel mixture enters the cylinder via an inlet port.
- After the suction process, the piston continues its upward movement and compresses the air-fuel mixture.
- At the end of the compression stroke, the compressed mixture is ignited due to the spark provided by a spark plug. As the mixture ignites, the power stroke piston starts.



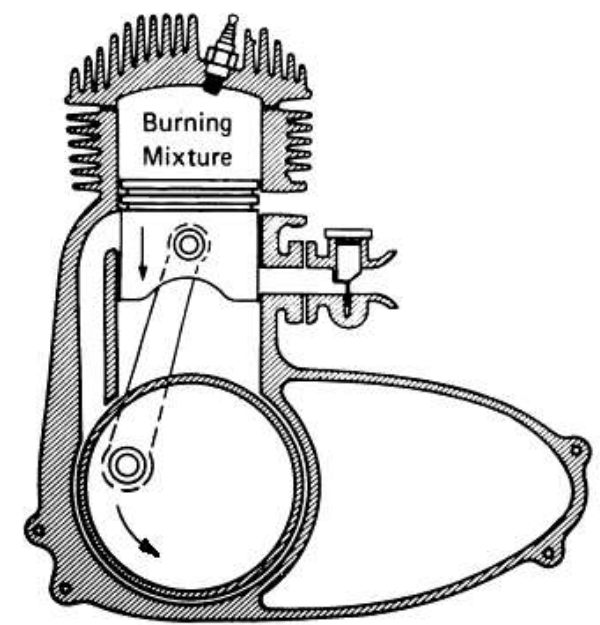
(a) Intake Crankcase to Cylinder (transfer)



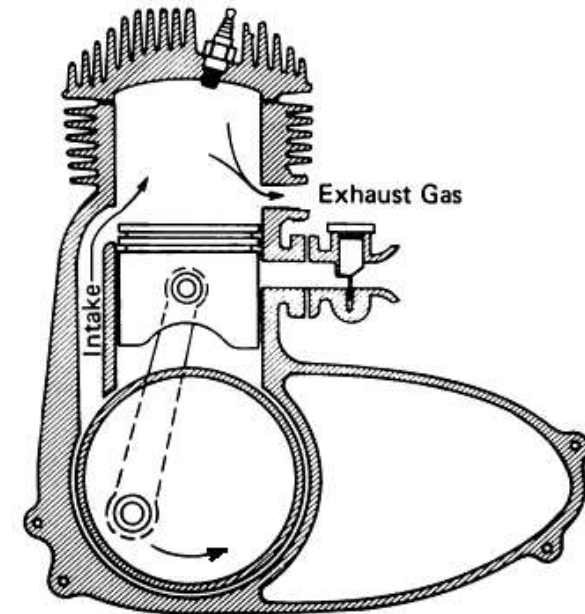
(b) Compression-Crankcase Intake

Power and Exhaust Stroke

- Like suction and compression strokes, the power and exhaust process also complete in just one stroke of the piston.
- Due to the combustion process, the temperature, internal heat, and pressure of the air-fuel mixture become very high. The high-pressure gases produced during the combustion process exert a very high force on the piston and force it to move downward (from TDC to BCD).
- The downward motion of the piston rotates the crankshaft, which further rotates the flywheel of the vehicle.
- As the power is completed, the piston further moves downward and opens the exhaust valve.
- As the exhaust valve opens, the piston pushes the exhaust gases out of the combustion chamber.
- As the piston reaches at BDC, the piston completely expels the exhaust gases and fills the combustion chamber with the fresh air-fuel mixture, and the whole working cycle repeats. At BDC, one power stroke of the engine is completed, and now the piston is ready for the next power cycle.

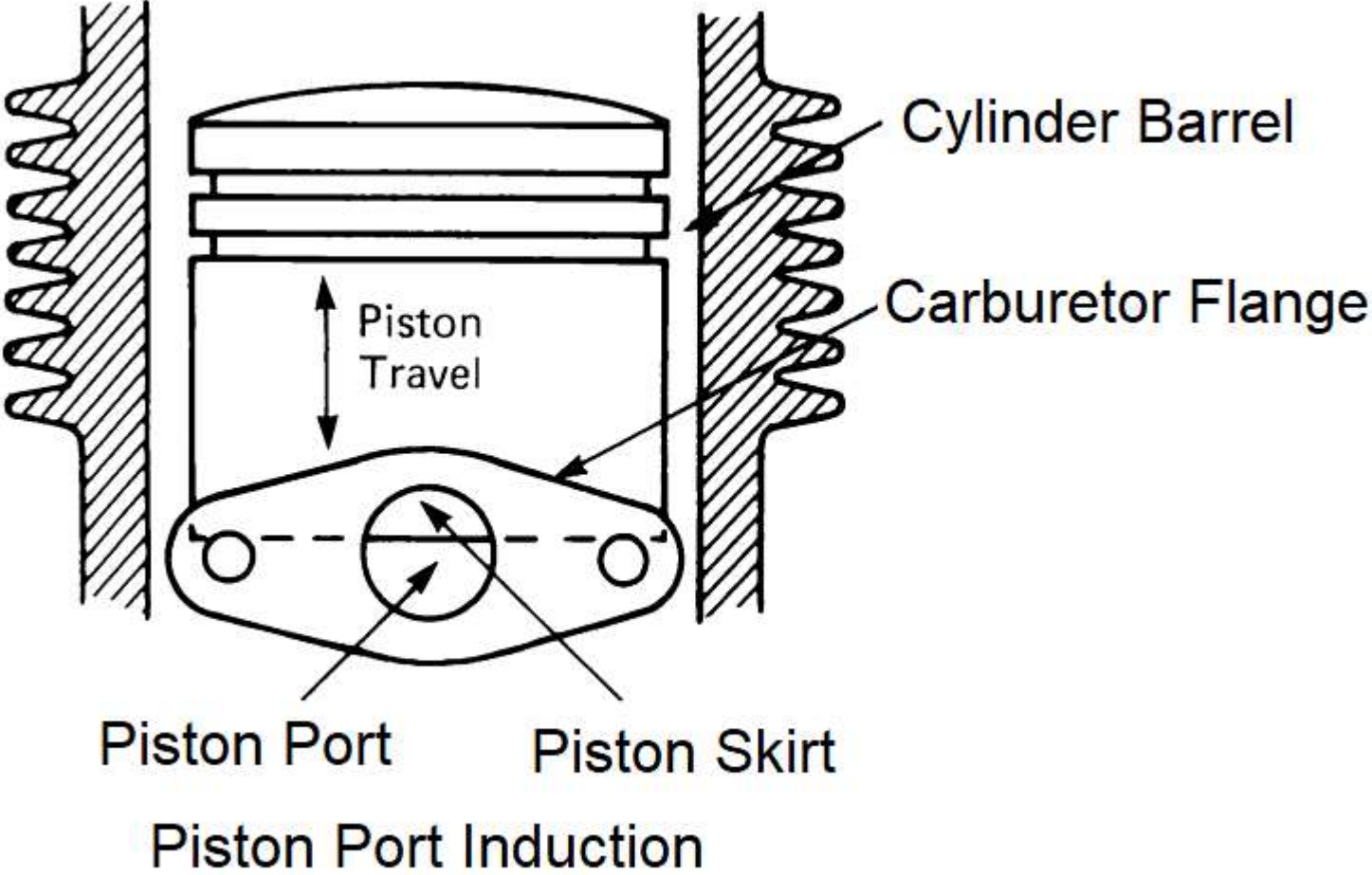
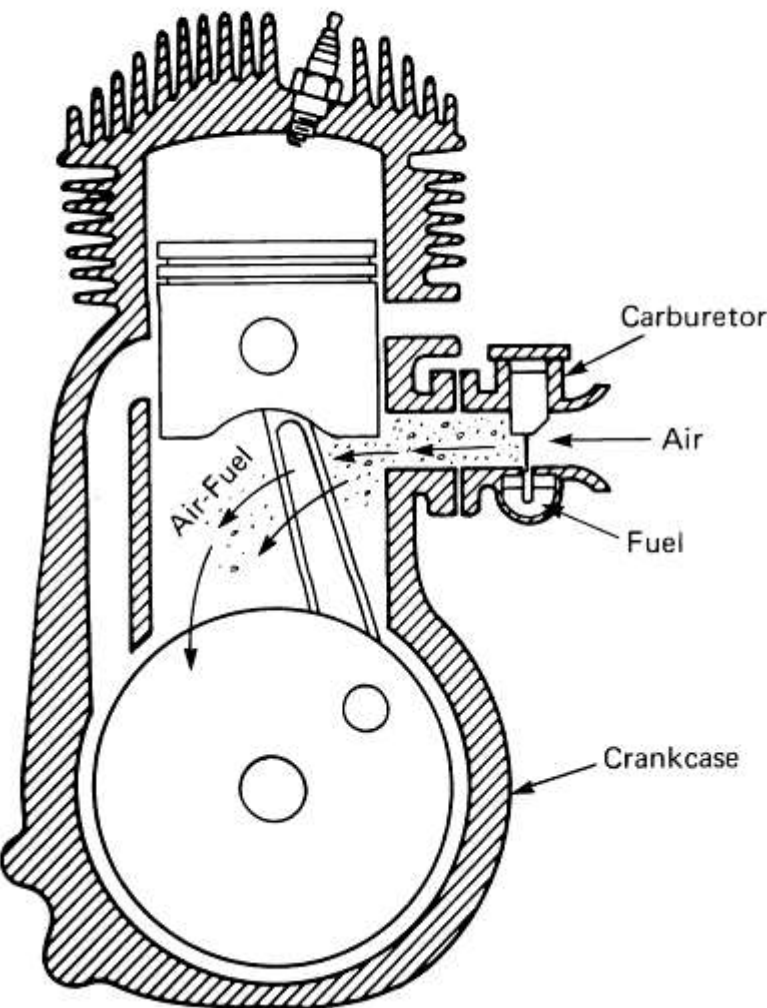


(c) Power-Crankcase Compression

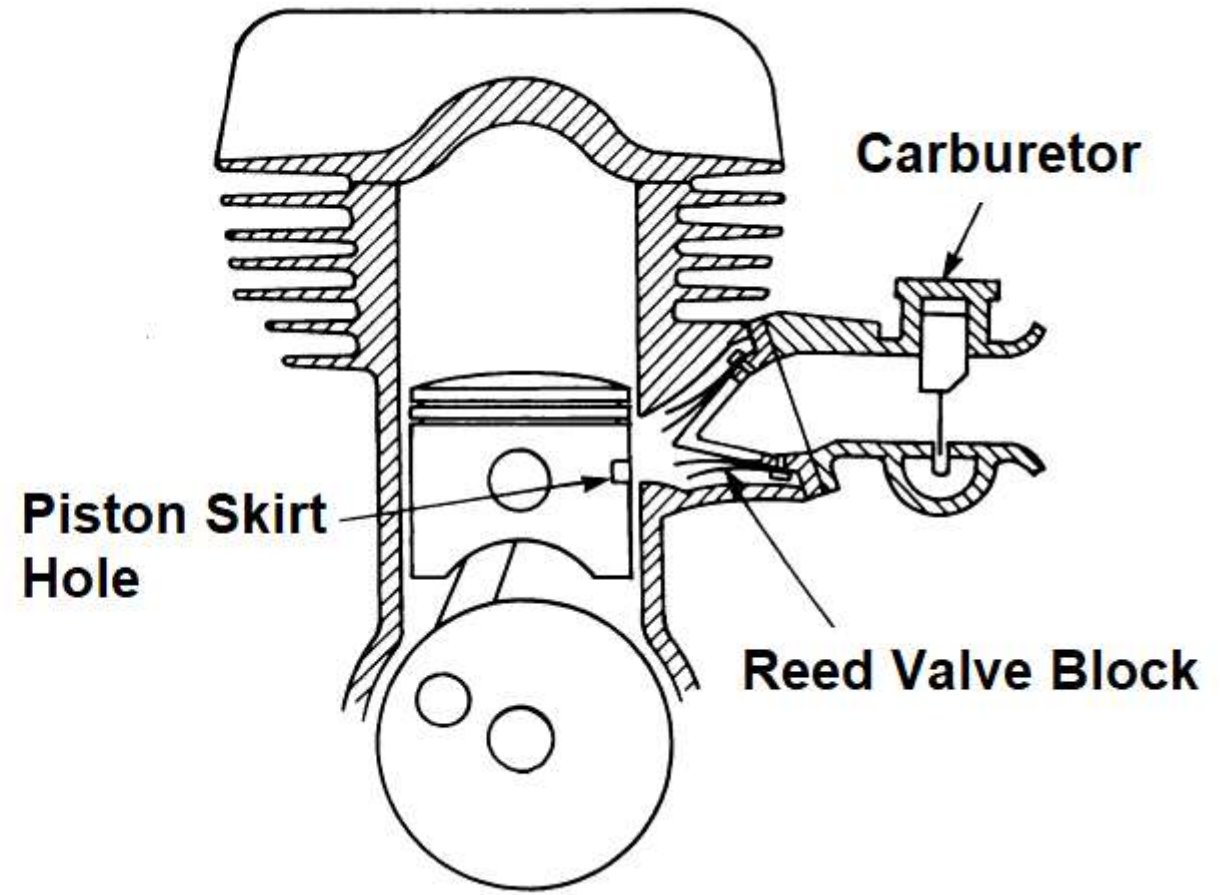
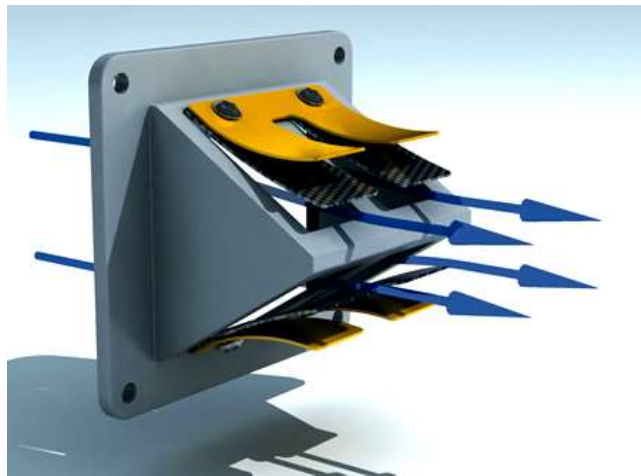
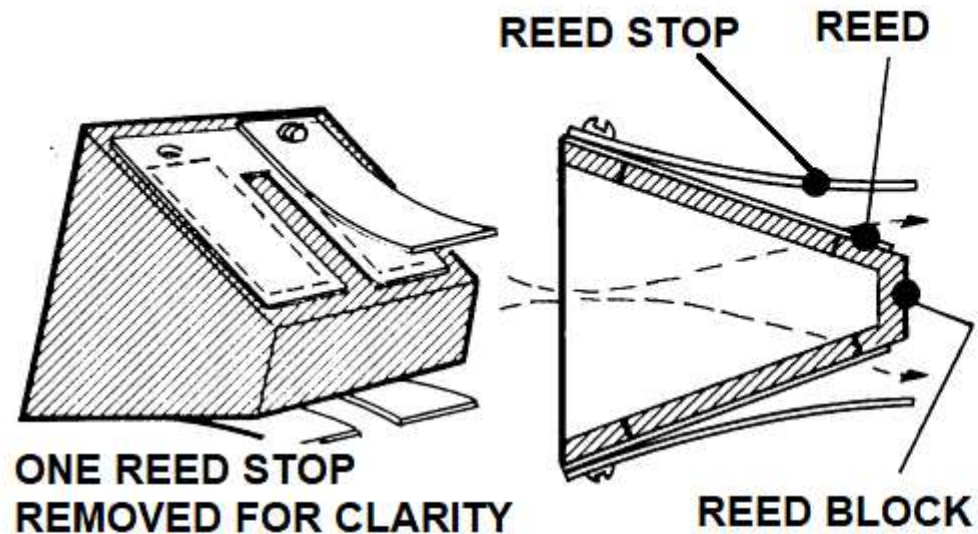


(d) Exhaust-then Intake

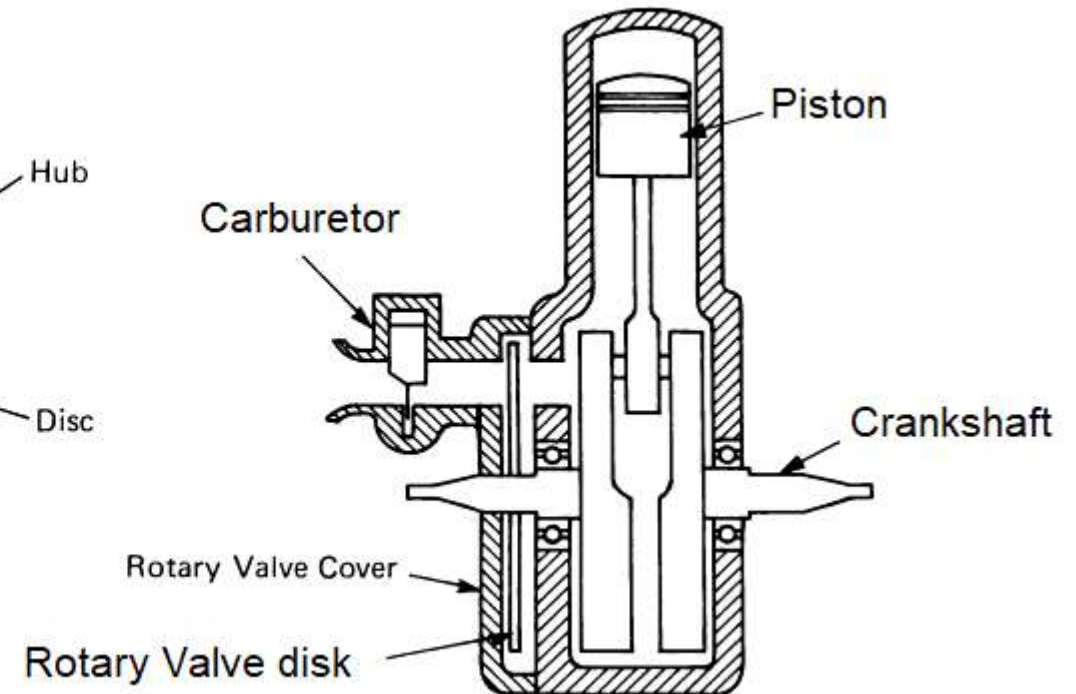
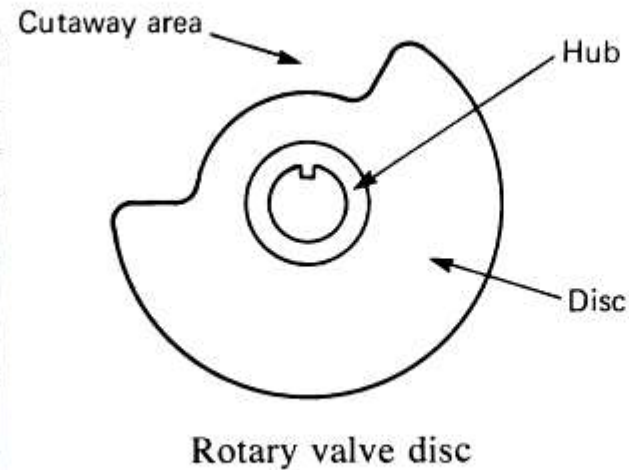
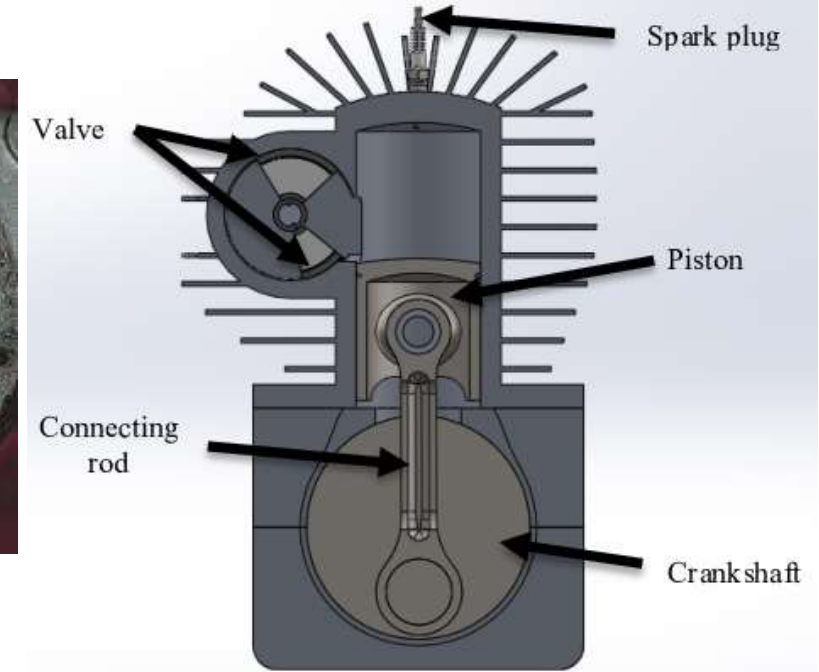
Inlet phase of fuel mixture from carburetor to crankcase

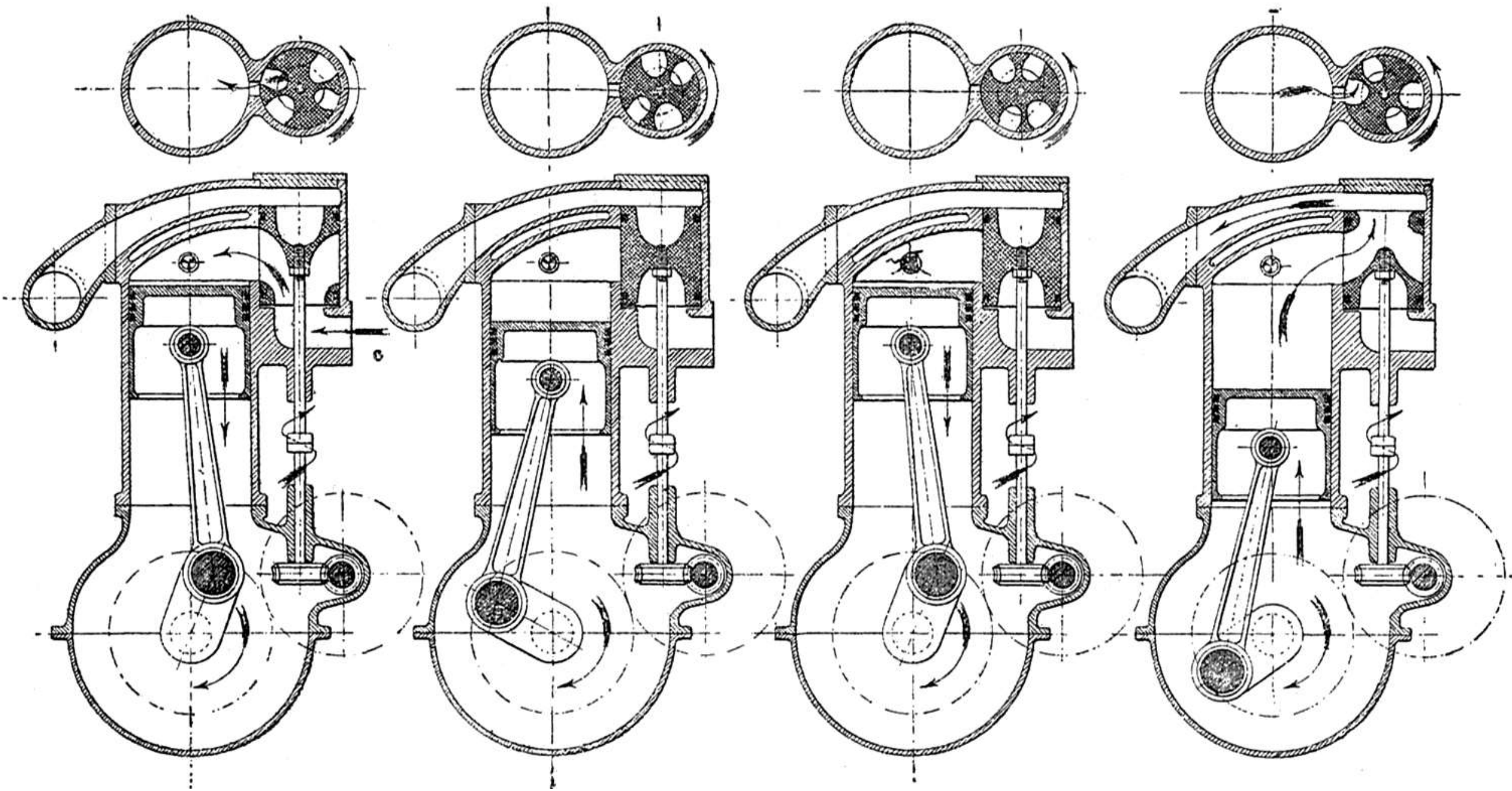


- **Reed valves** are a type of check valve which restrict the flow of fluids to a single direction, opening and closing under changing pressure on each face. Modern versions often consist of flexible metal or composite materials

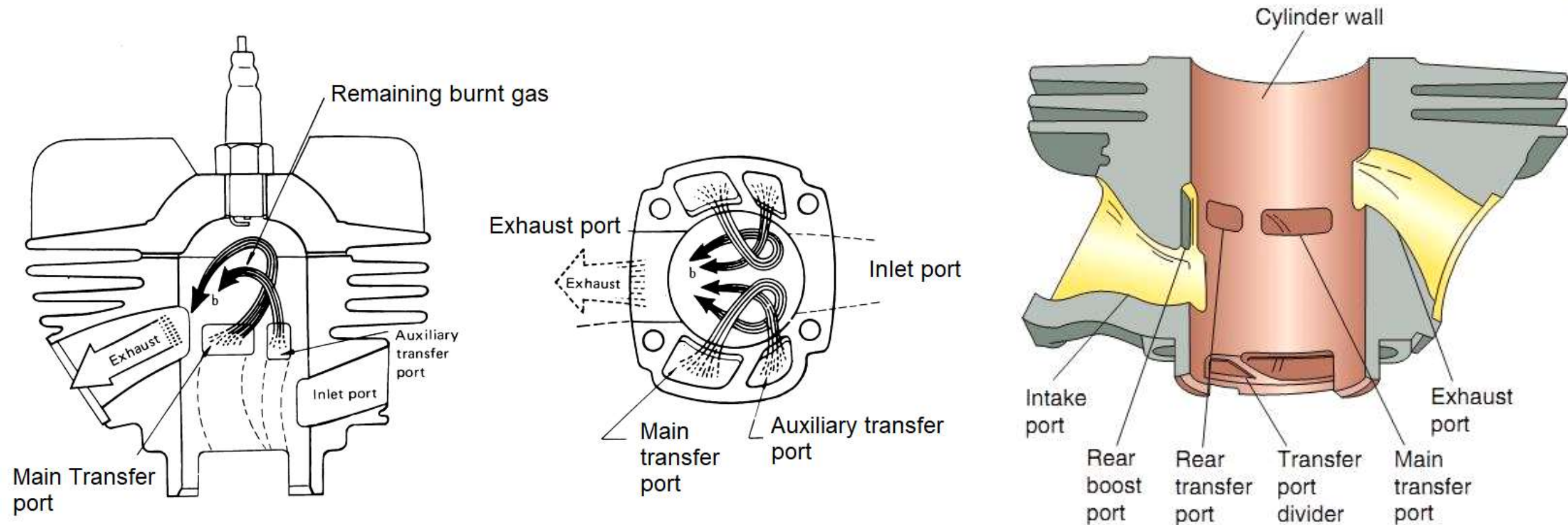


- A **rotary valve** as used in a 2 stroke motorcycle engine is simply a round disc with a specific cutout around the perimeter that is keyed to the crankshaft. The purpose is to function as a means of closing off the intake tract at a specific time and duration

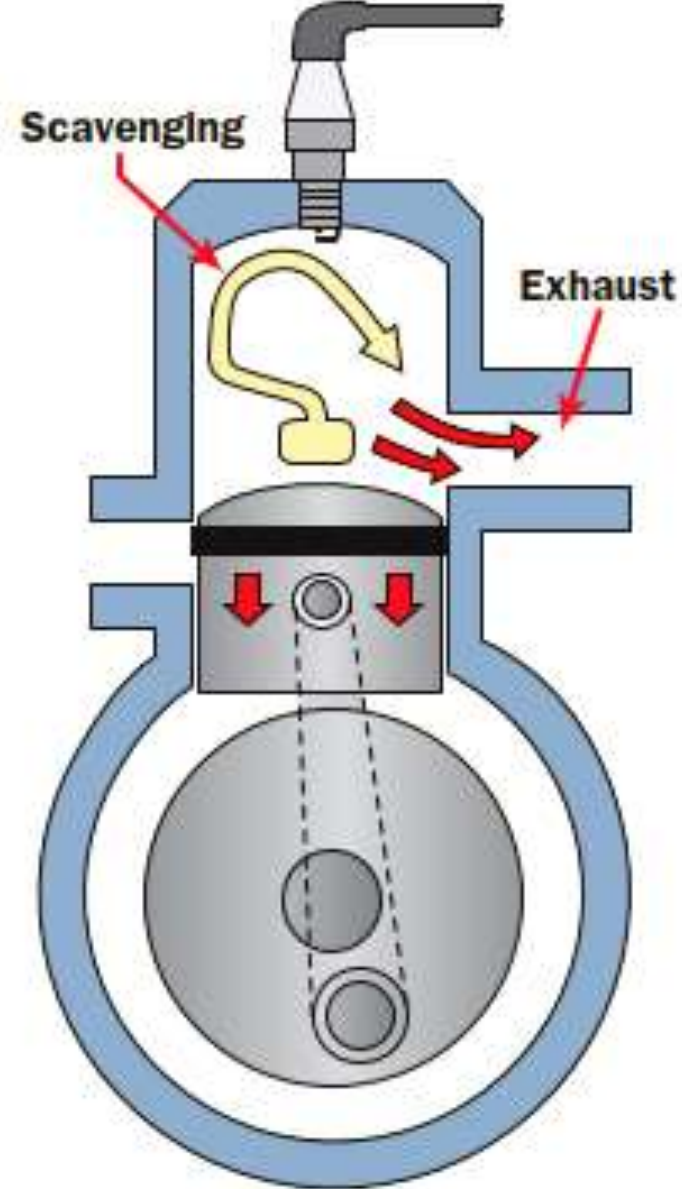
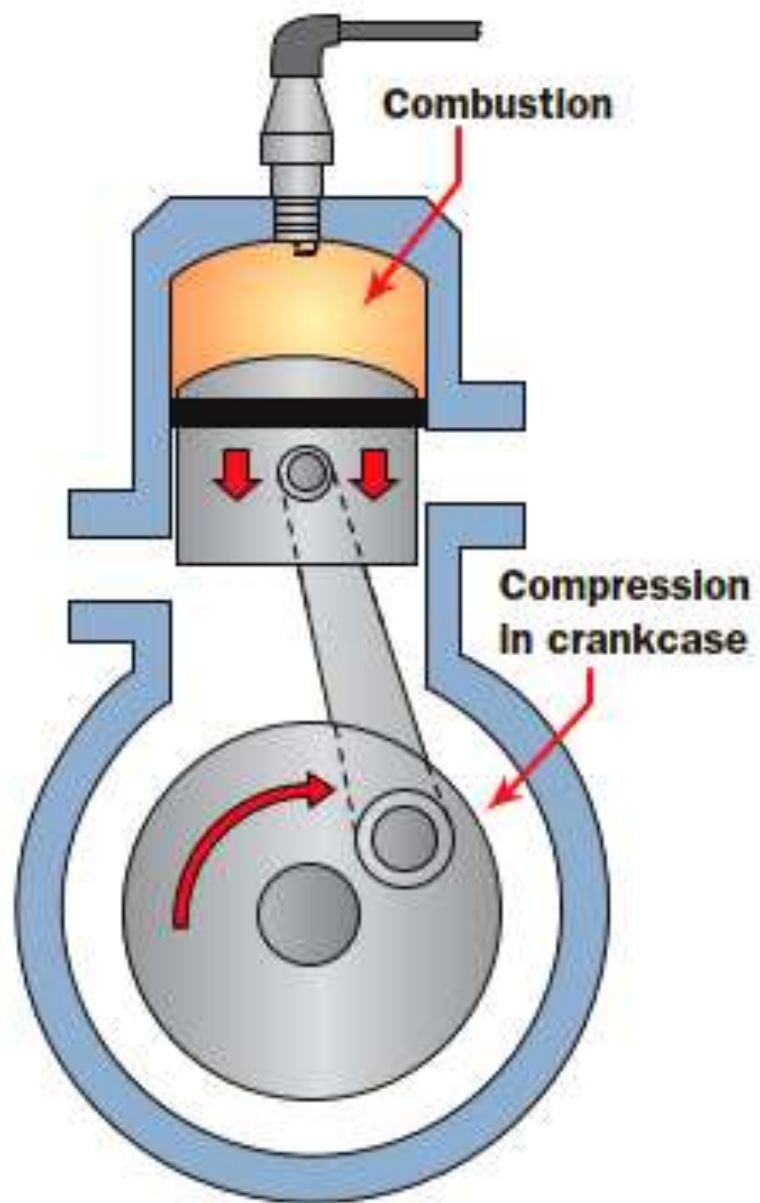




- **The transfer (Inlet) ports** are responsible for moving fresh air and fuel up from the crankcase into the cylinder. **The exhaust ports** dictate how much and how well exhaust gases depart the cylinder. Similar to the transfer ports, the duct shape, angle, length and volume have a large influence on how well gases can flow through the port. Typically, dirt bike engines commonly feature bridge port or triple port designs.



Ignition and power stroke



Displacement. Displacement refers to the volume of mixture that is drawn into the cylinder with each downward stroke of the piston.

$$D = \pi R^2 S$$

D = Displacement

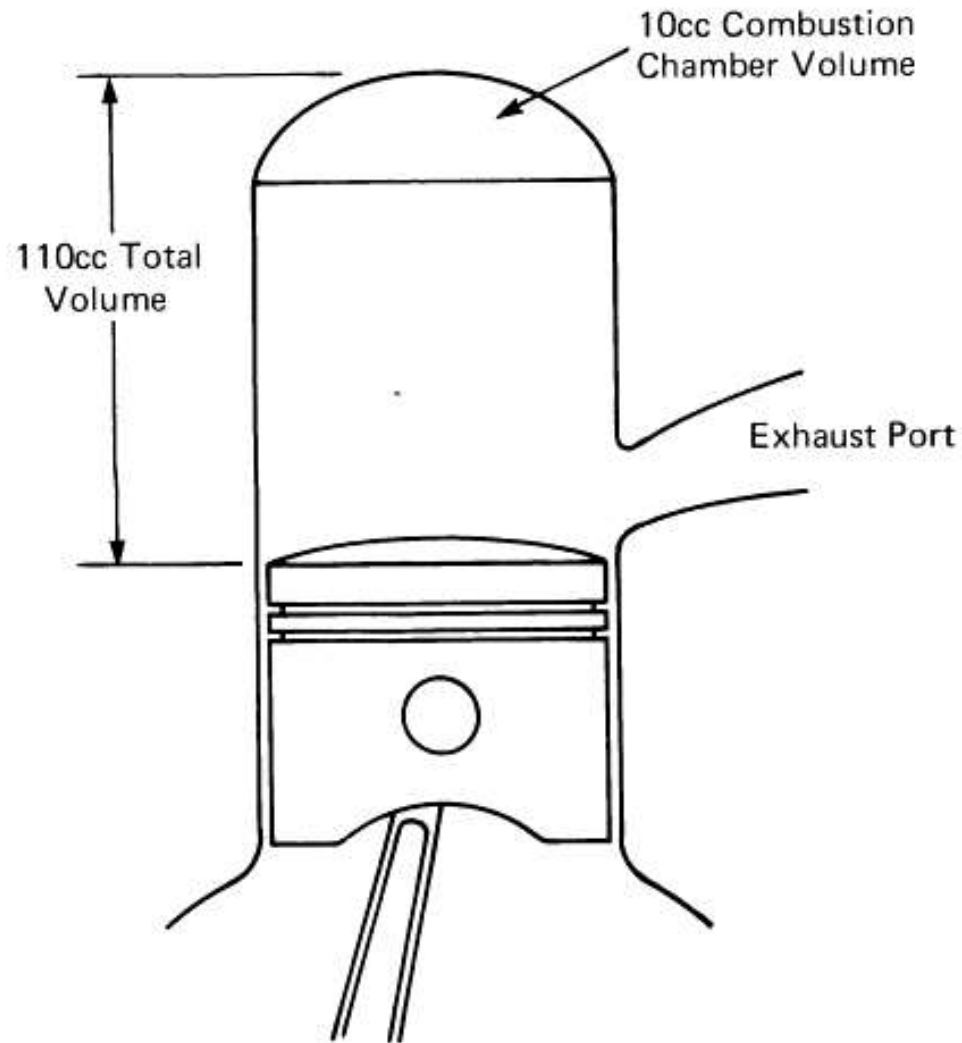
$$\pi = 3.1416$$

R = Radius of Cylinder (1/2 bore)

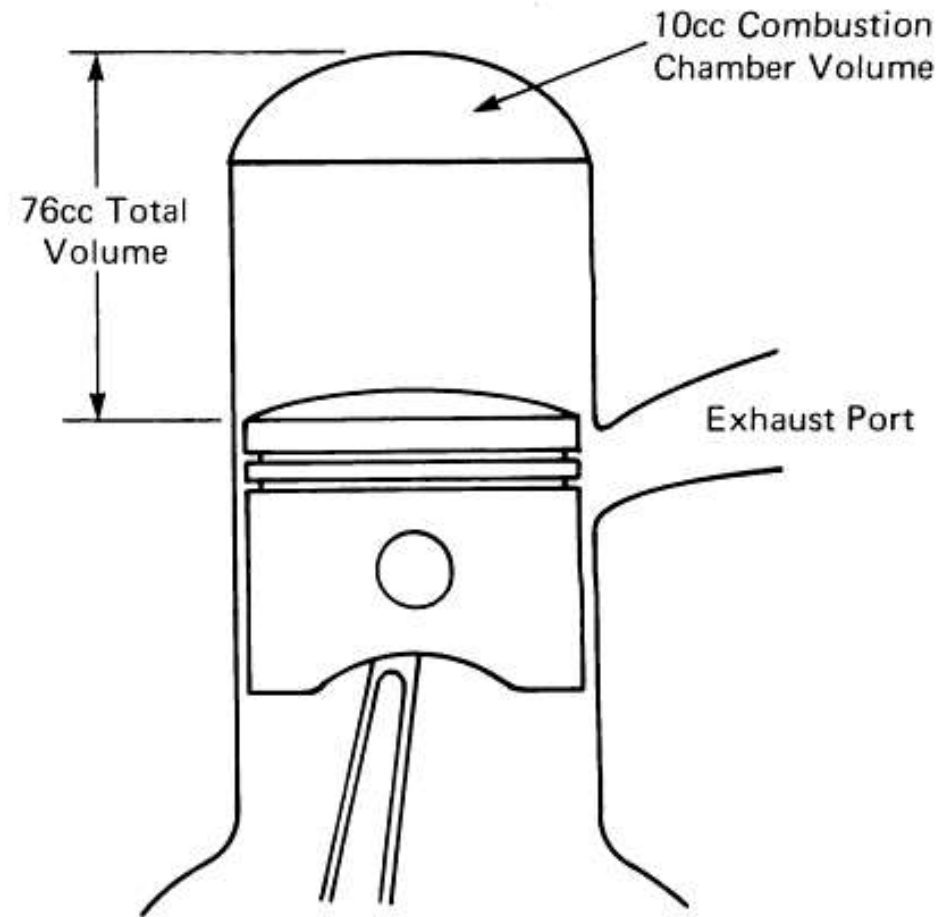
S = Stroke

Compression Ratio. Compression ratio is the numerical relationship between the volume in the cylinder at the beginning of the compression phase and the volume in the combustion chamber at T.D.C.

European compression ratio



Japanese compression ratio

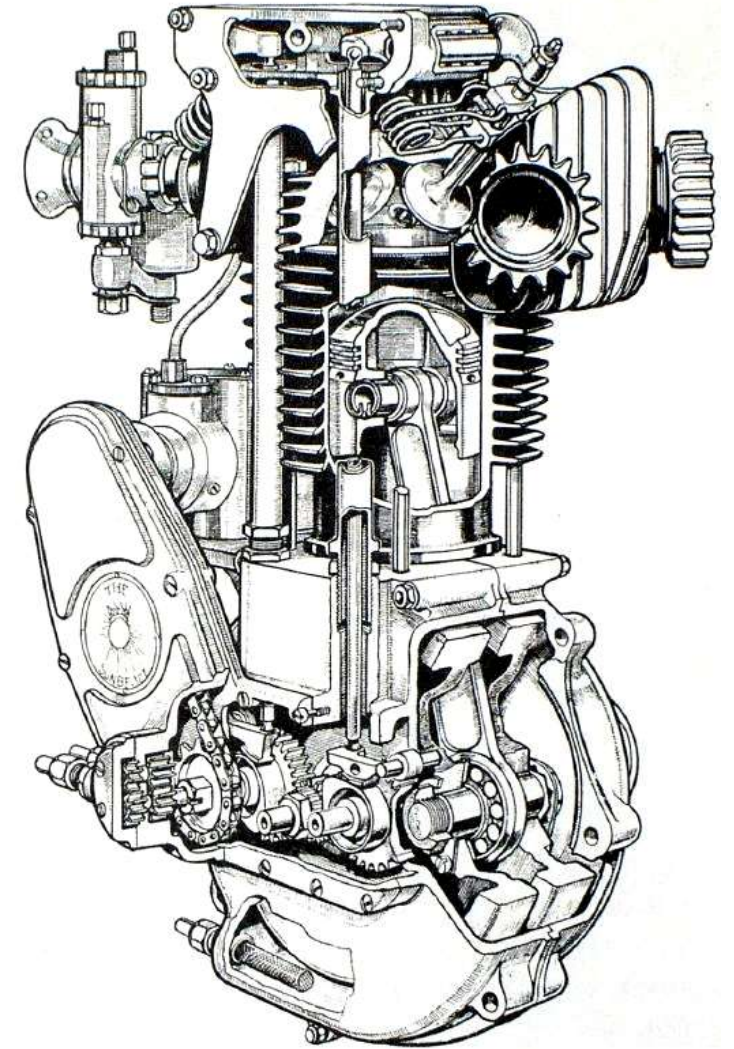
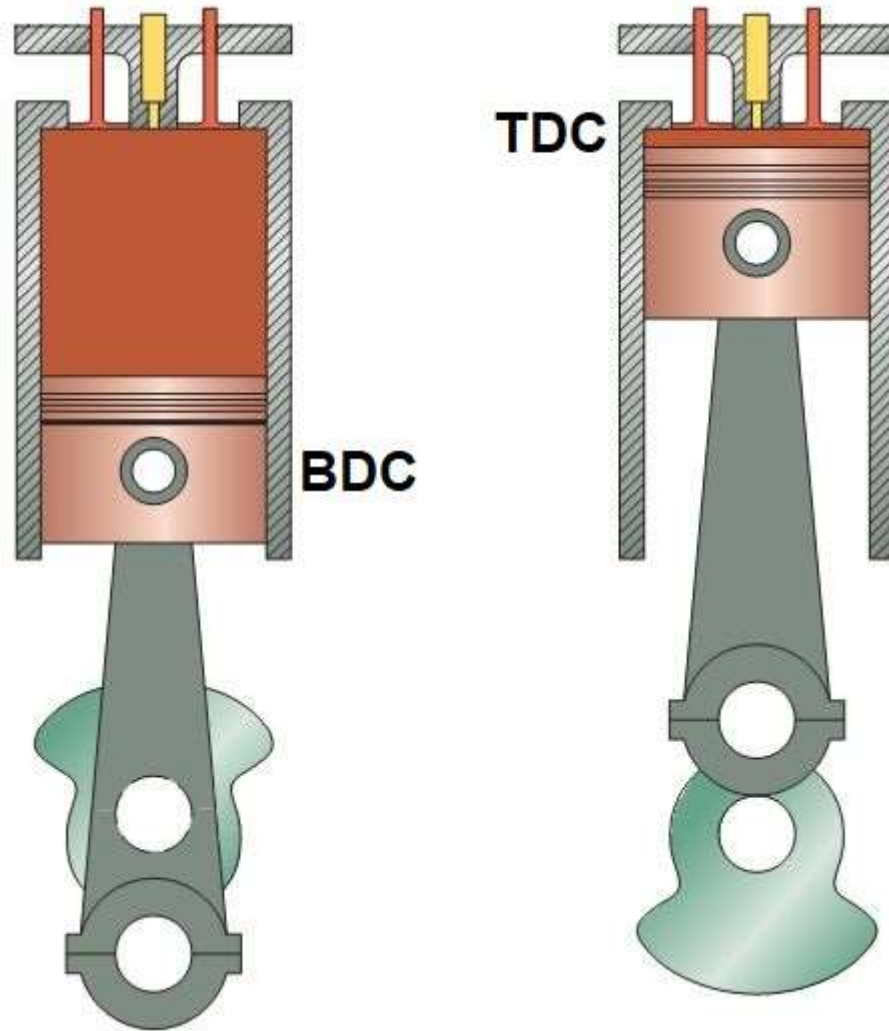


Four Stroke Engine Upper End

- A **four-stroke** (also **four-cycle**) **engine** is an internal combustion (IC) engine in which the piston completes four separate strokes while turning the crankshaft. A stroke refers to the full travel of the piston along the cylinder, in either direction



TDC – Top Dead Centre is traditionally the position of an internal combustion engine's piston when it is at the very top of its stroke. **BDC** – Bottom Dead Centre is the opposite, when the piston is at the very bottom of its stroke.



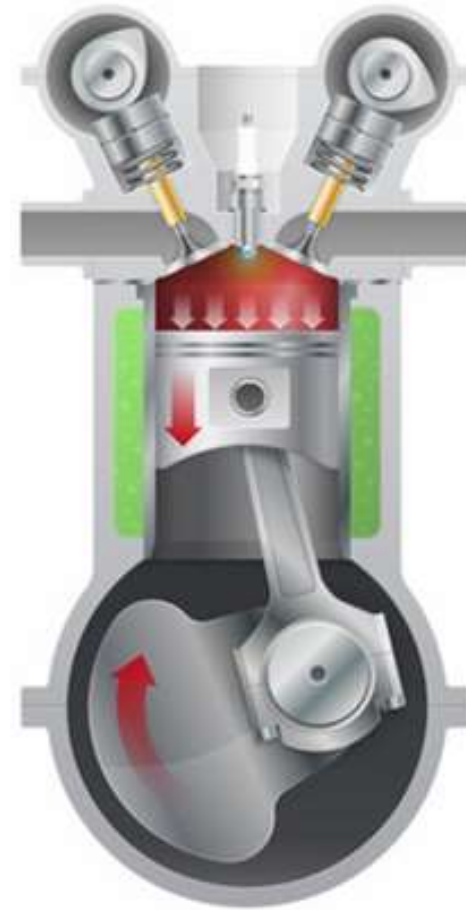
Intake: stroke of the piston begins at top dead center (T.D.C.) and ends at bottom dead center (B.D.C.). In this stroke the intake valve must be in the open position while the piston pulls an air-fuel mixture into the cylinder by producing a partial vacuum (negative pressure) in the cylinder through its downward motion.

Compression: This stroke begins at B.D.C, or just at the end of the suction stroke, and ends at T.D.C. In this stroke the piston compresses the air-fuel mixture in preparation for ignition during the power stroke (below). Both the intake and exhaust valves are closed during this stage.

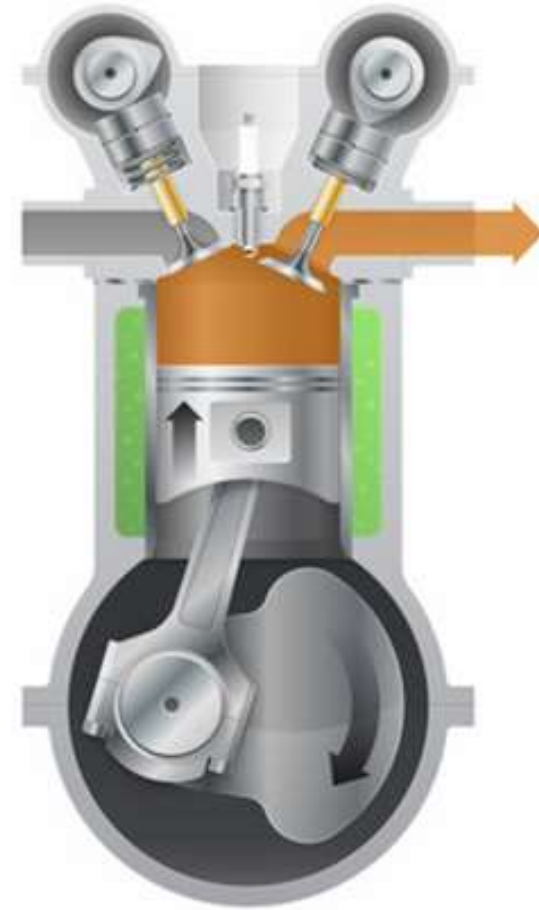


Combustion: Also known as power or ignition. This is the start of the second revolution of the four stroke cycle. At this point the crankshaft has completed a full 360 degree revolution. While the piston is at T.D.C. (the end of the compression stroke) the compressed air-fuel mixture is ignited by a spark plug (in a gasoline engine), forcefully returning the piston to B.D.C. This stroke produces mechanical work from the engine to turn the crankshaft.

Exhaust: During the *exhaust* stroke, the piston, once again, returns from B.D.C. to T.D.C. while the exhaust valve is open. This action expels the spent air-fuel mixture through the exhaust port.



3 POWER



4 EXHAUST

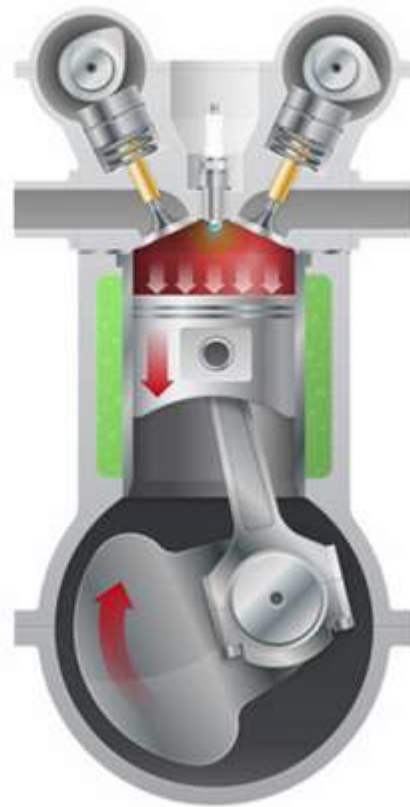
FOUR STROKE CYCLE ENGINE



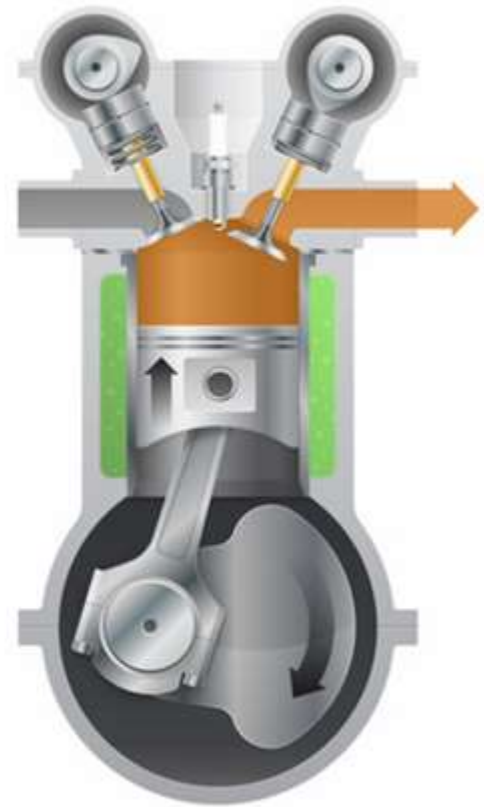
1 INTAKE



2 COMPRESSION



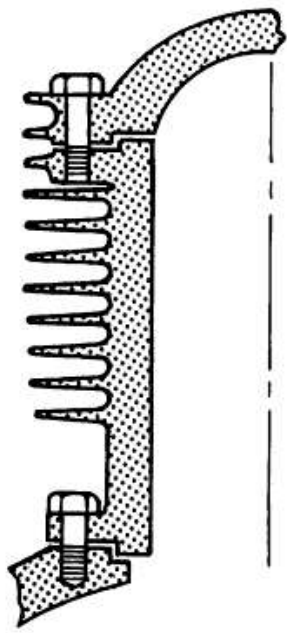
3 POWER



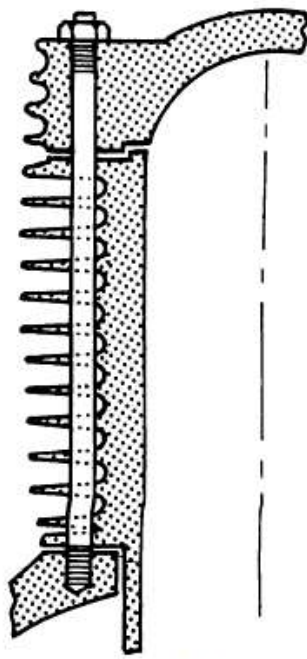
4 EXHAUST

- Add animated four stroke engine videos

Top Ends Parts

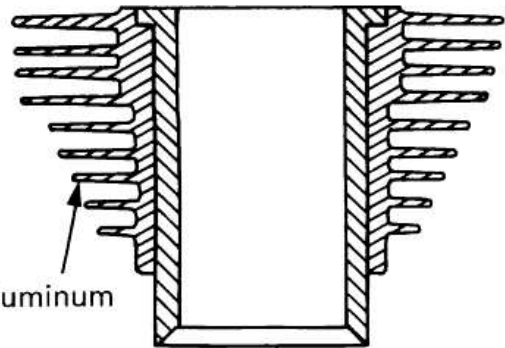
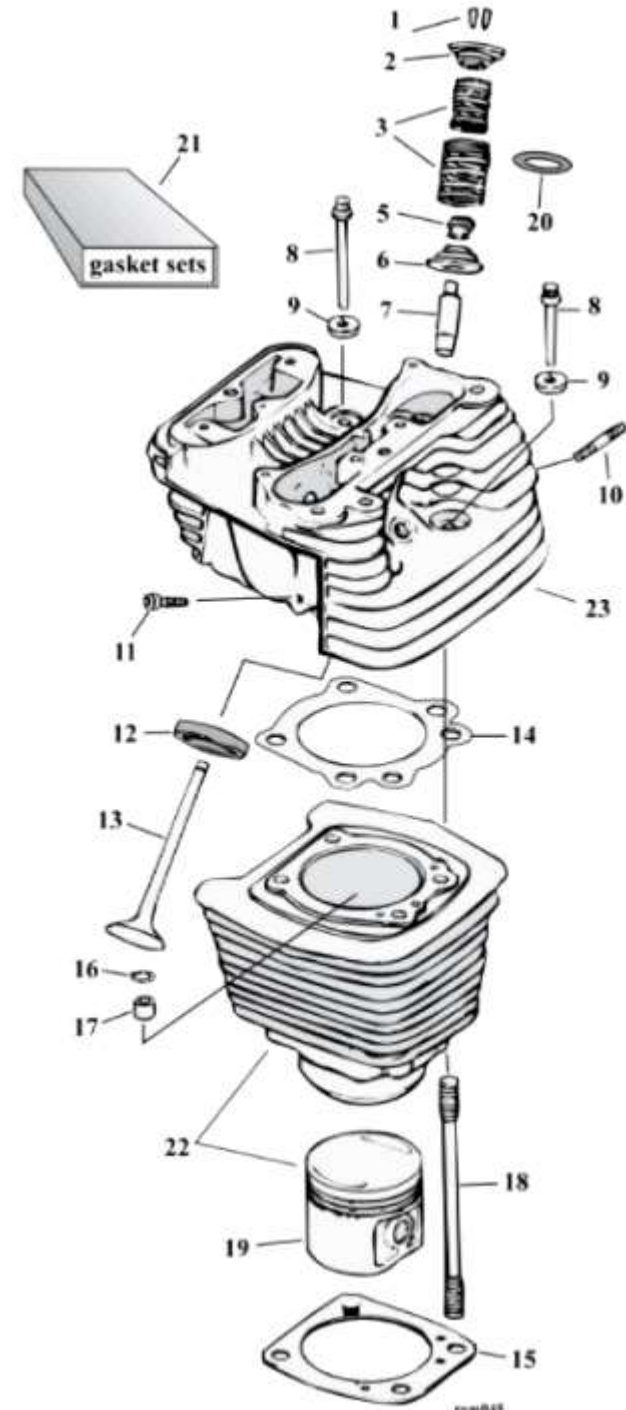


Flanged Barrel

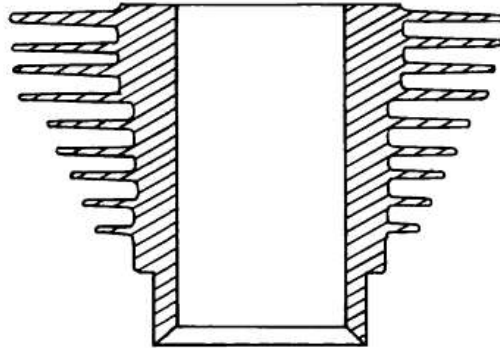


Long-Stud Barrel

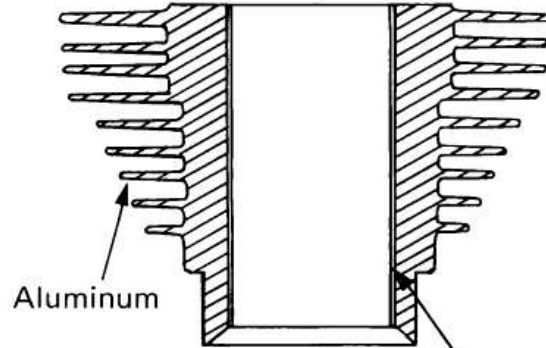
Typical cylinder hold-downs



iron-lined aluminum



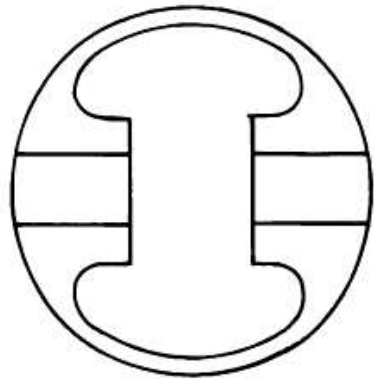
cast iron



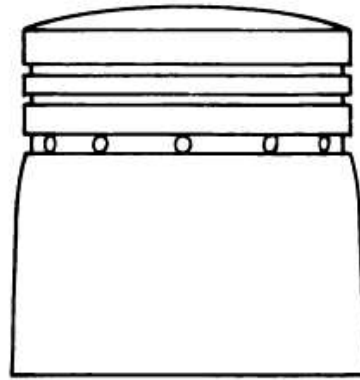
chrome plated aluminum

Piston

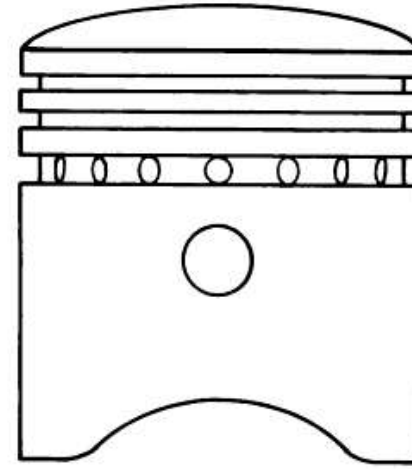
- The **piston** is a moving part of the combustion chamber. It is responsible for converting the energy released during the combustion process into mechanical work.



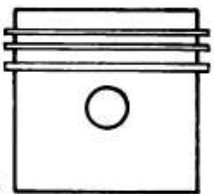
(a) Slightly Oval
(cross section)



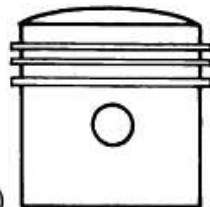
(b) Piston Skirt Taper



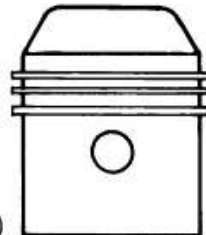
Piston design showing two top compression ring grooves and the oil groove with drilled holes



(a)



(b)

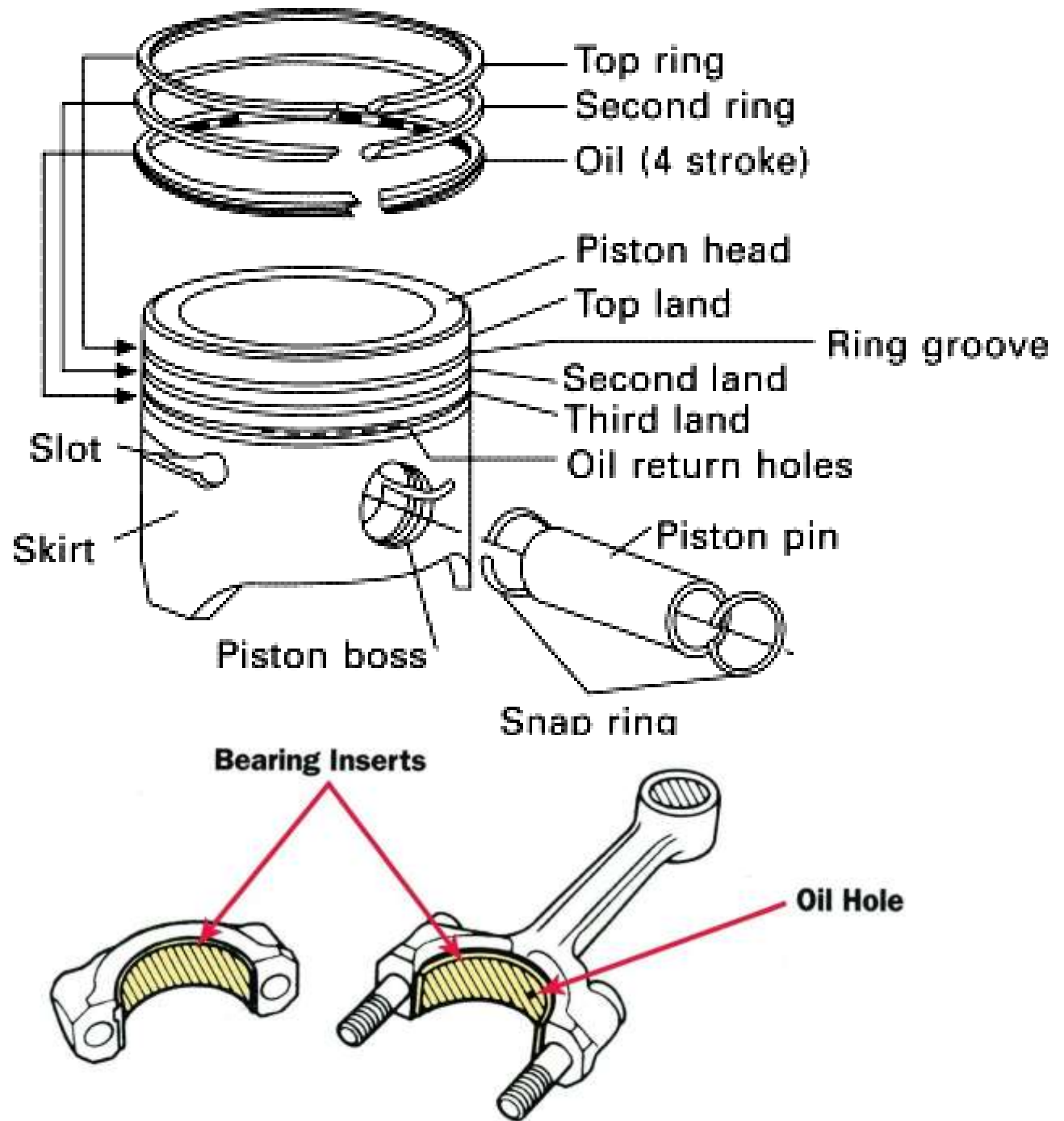


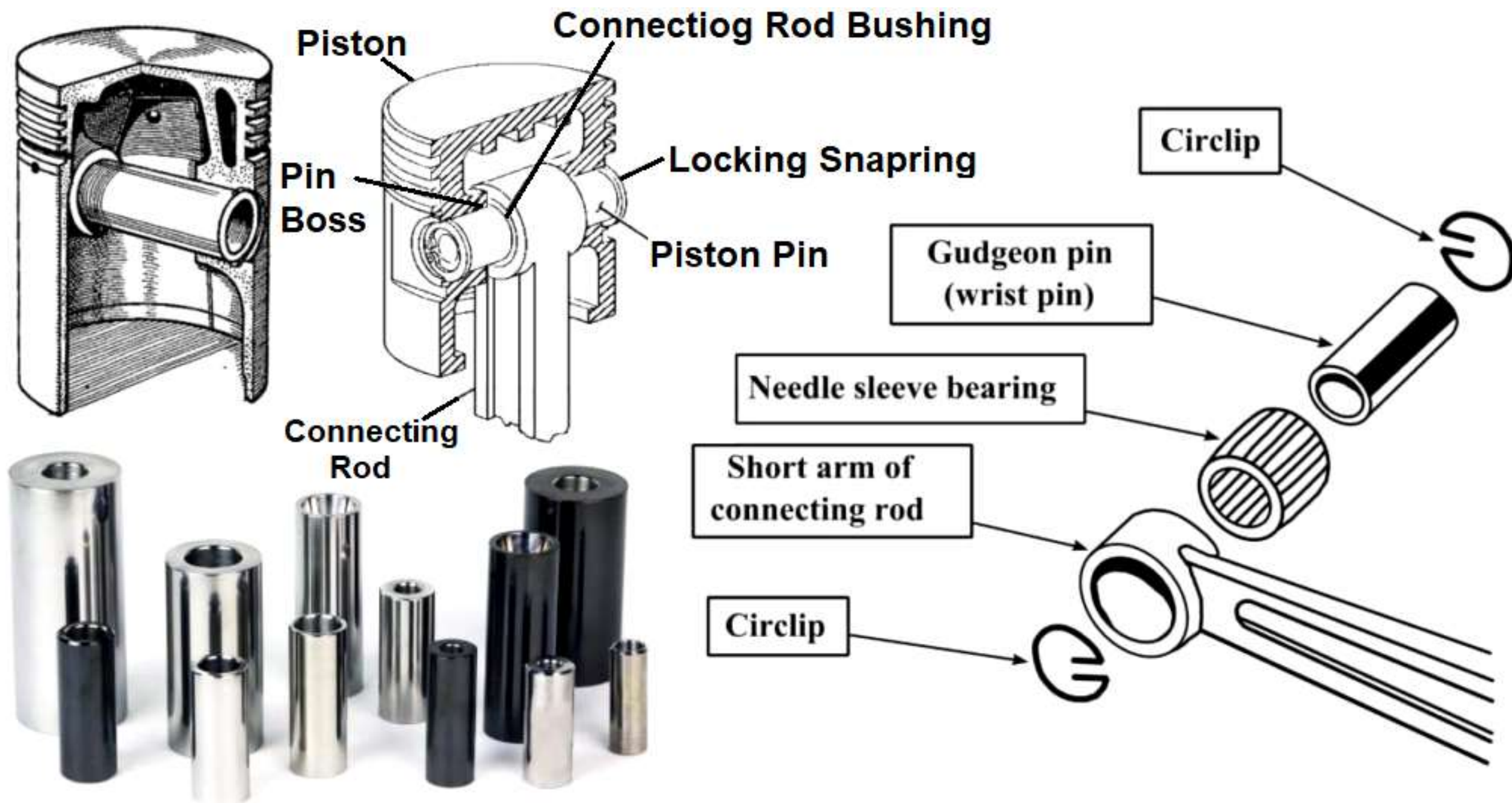
(c)



Piston pin retaining clips showing three common types of clips

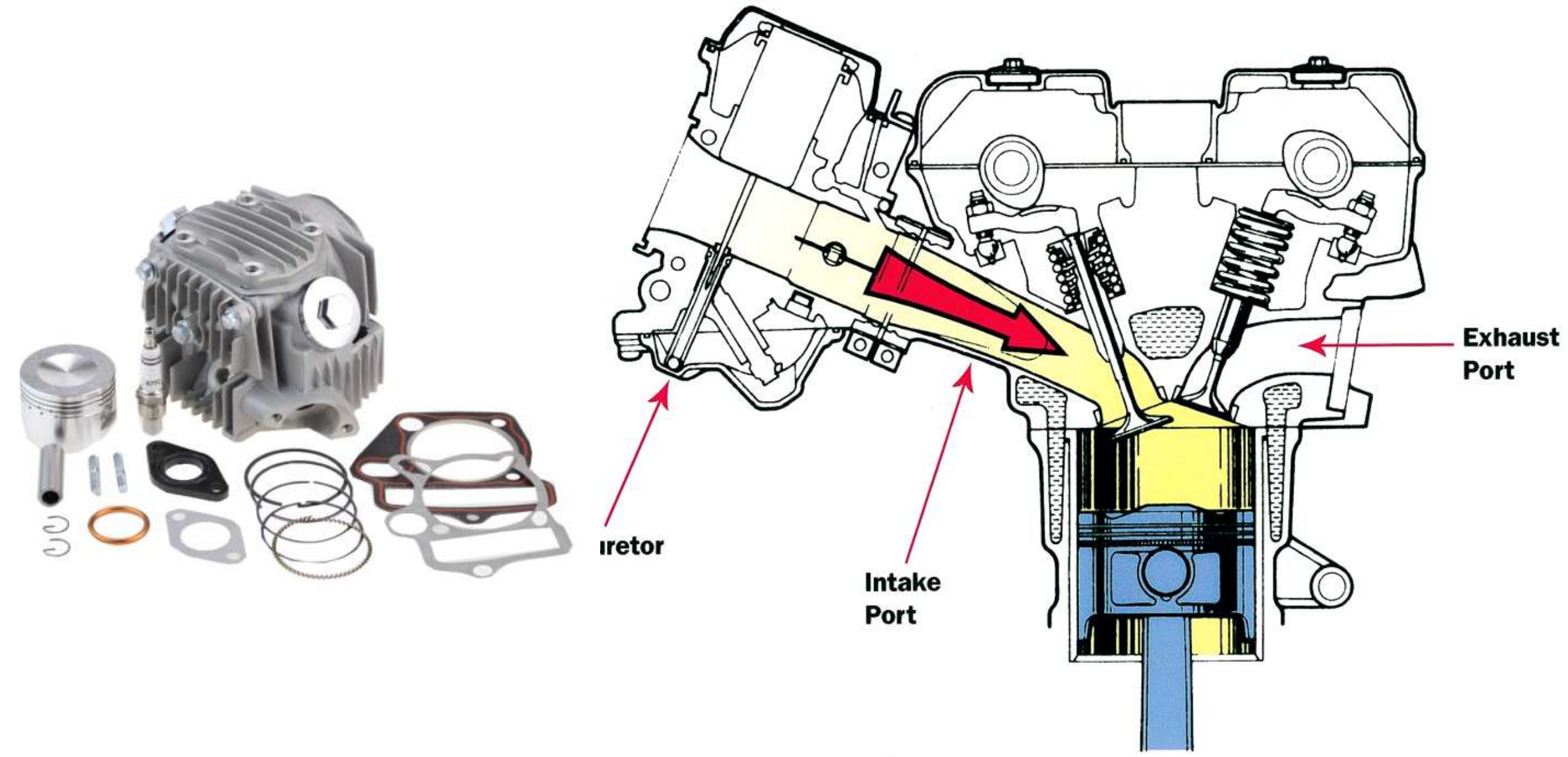
- **Piston Rings** form a seal between the piston and cylinder wall, which prevents pressurized combustion gases from entering the oil sump. They also regulate oil consumption by preventing excessive oil from entering the combustion chamber and burning.





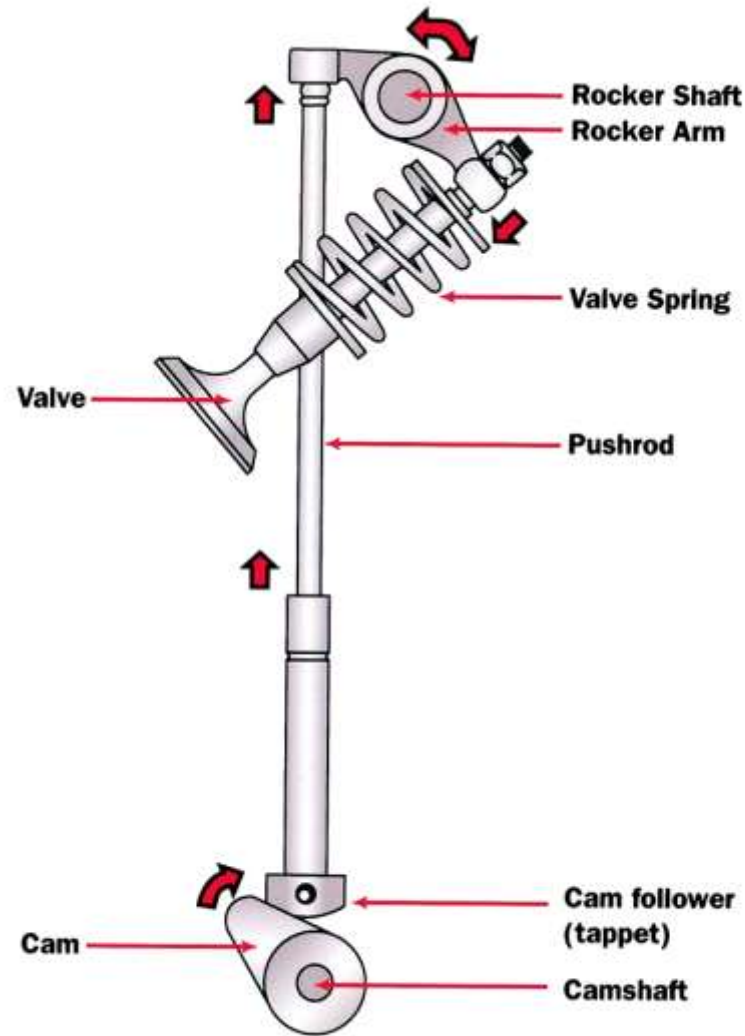
- **Cylinder Head**

4-Stroke Engines

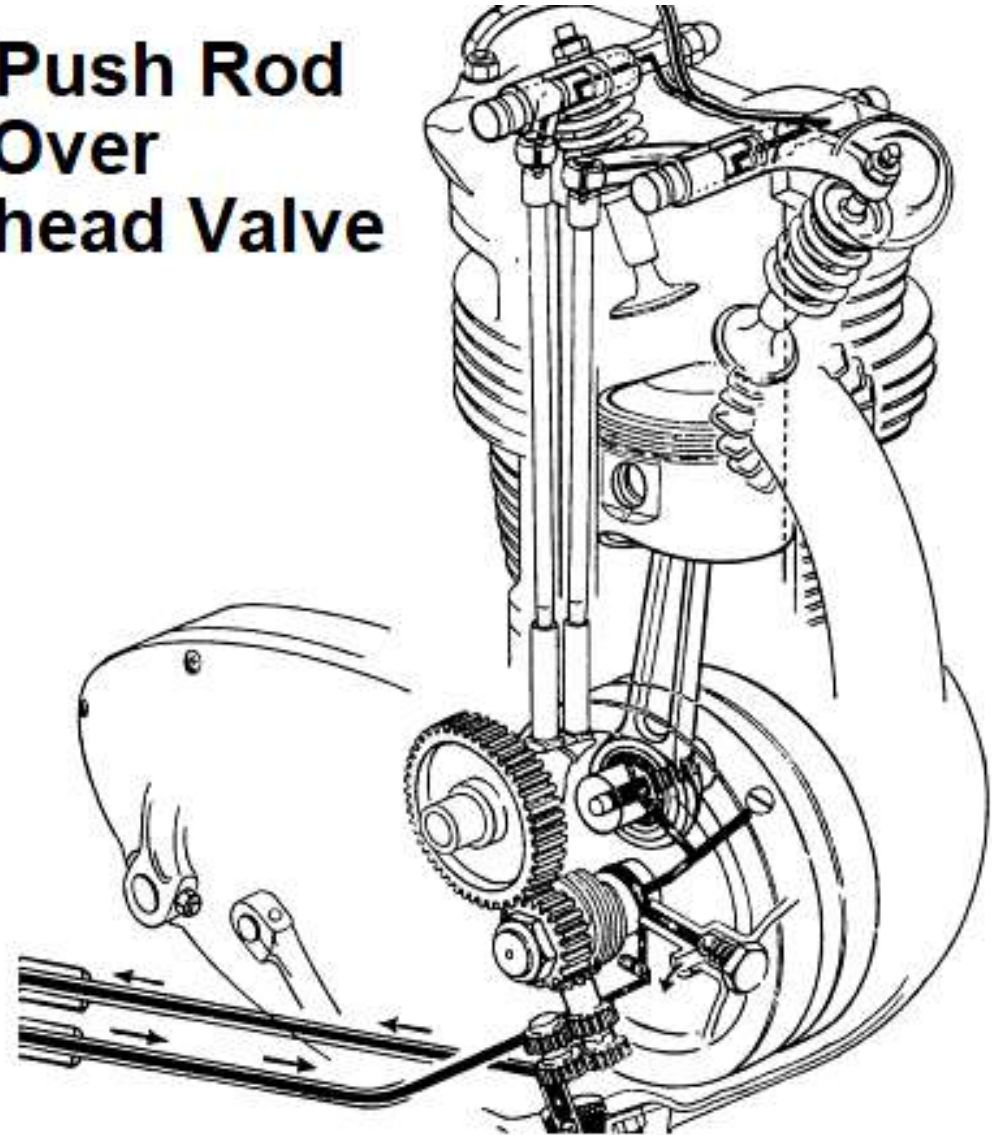


- **Pushrods Over Head Valve**

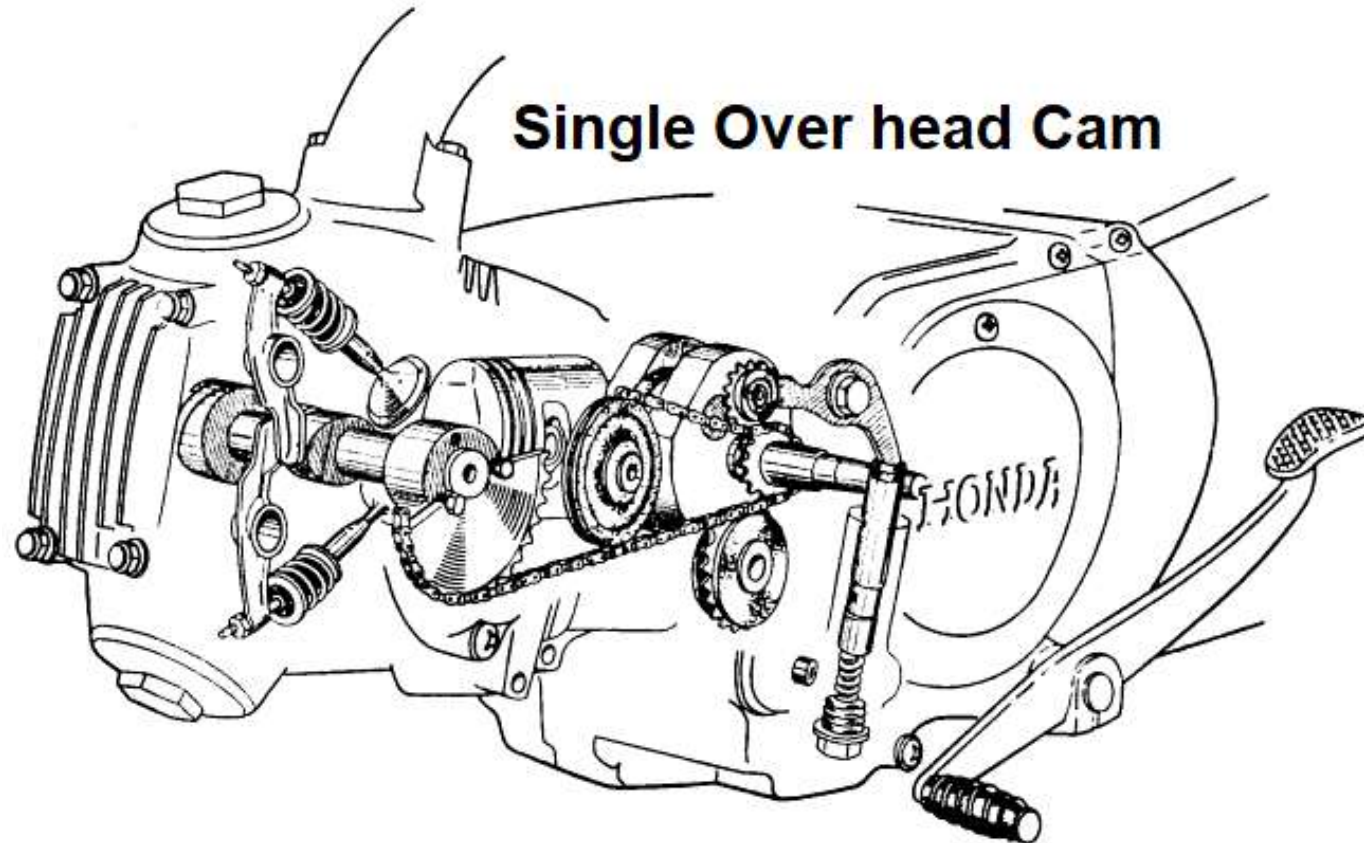
Pushrods are long, slender metal rods that are used in overhead valve engines to transfer motion from the camshaft (located in the engine block) to the valves (located in the cylinder head). The bottom end of a pushrod is fitted with a lifter, upon which the camshaft makes contact.



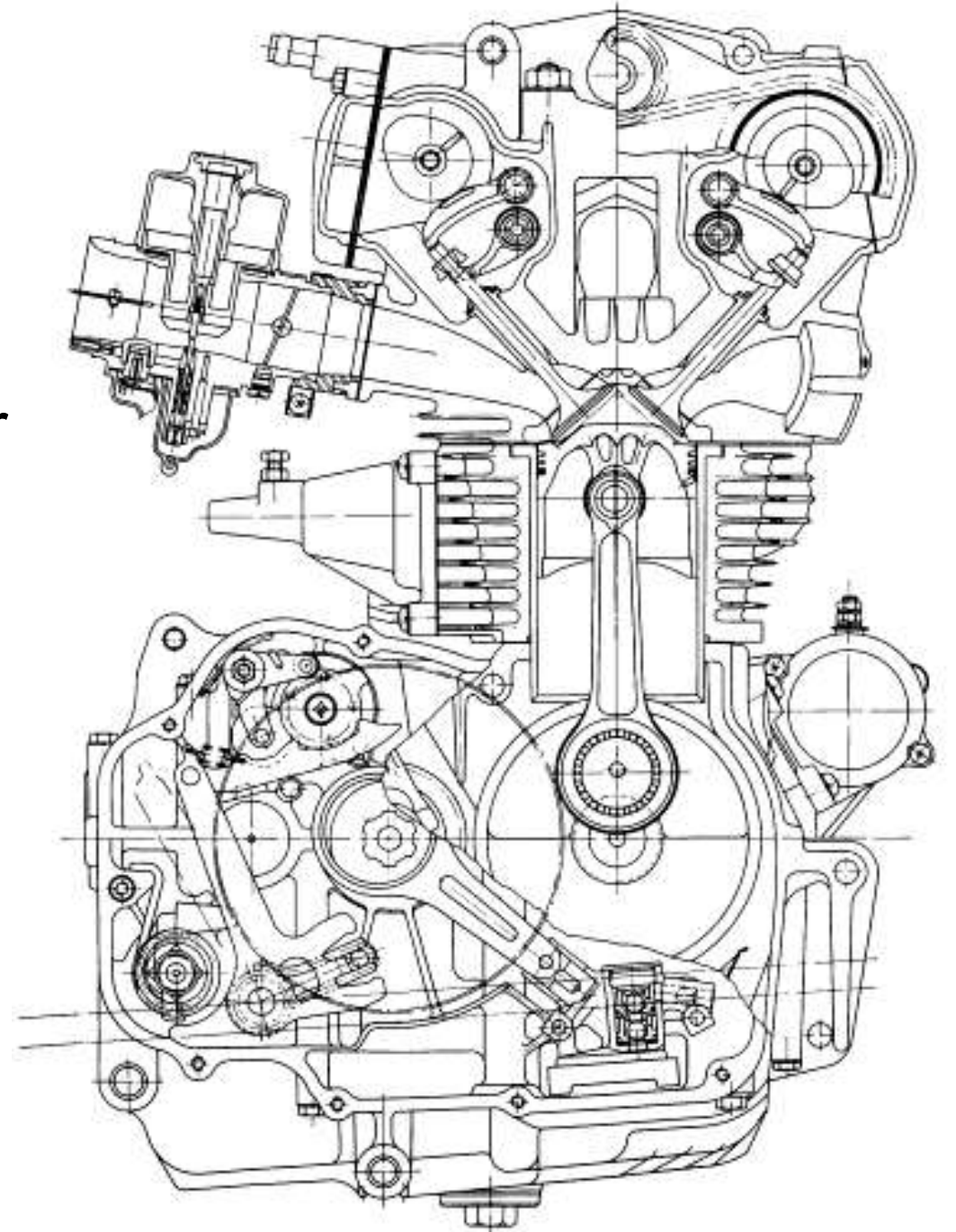
Push Rod Over head Valve



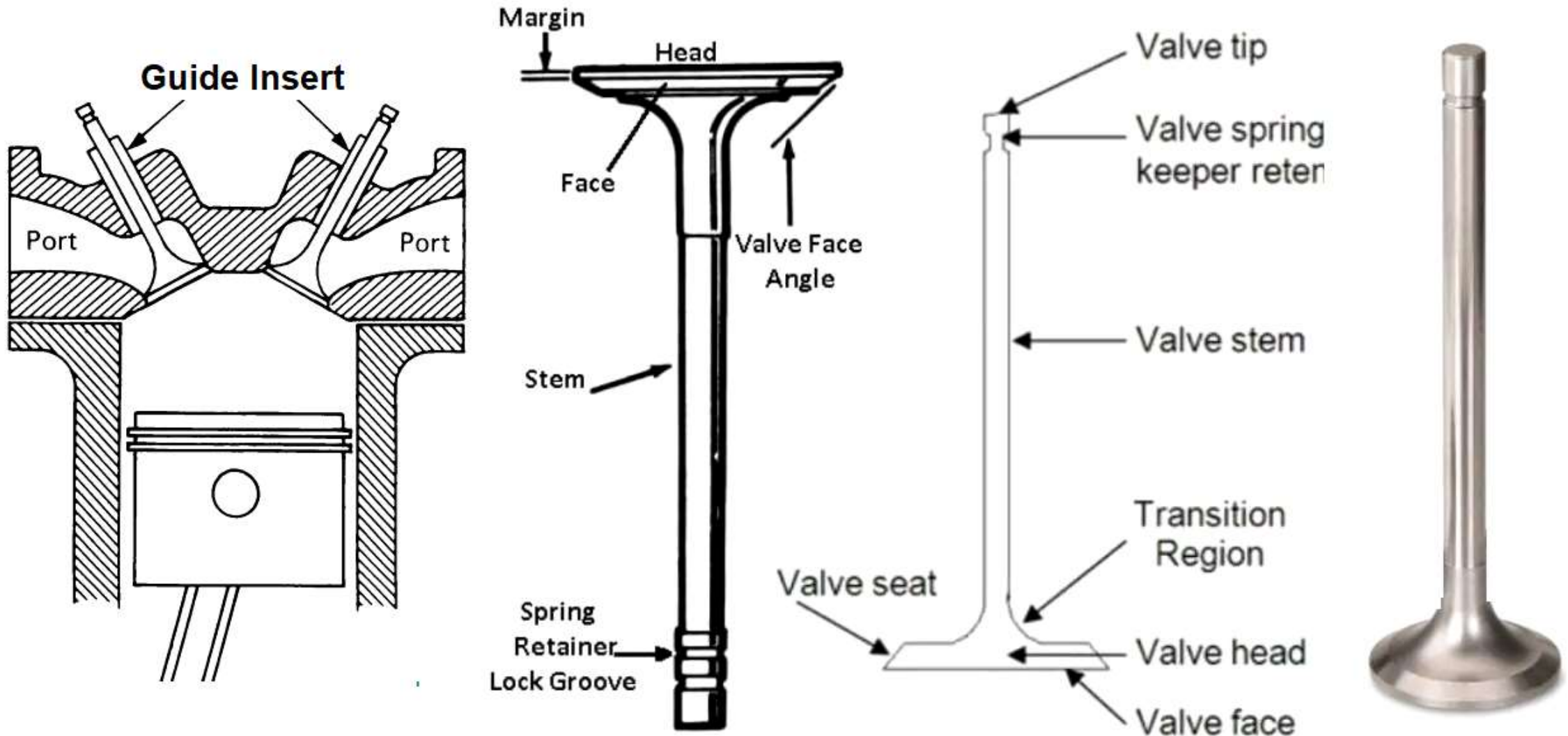
- **SOHC. Single overhead cam** or overhead cam engines have a single camshaft installed in the cylinder head. The valves are operated directly by the camshaft and it is much easier to maintain precise timing at higher RPM and 3 or 4 valves per cylinder



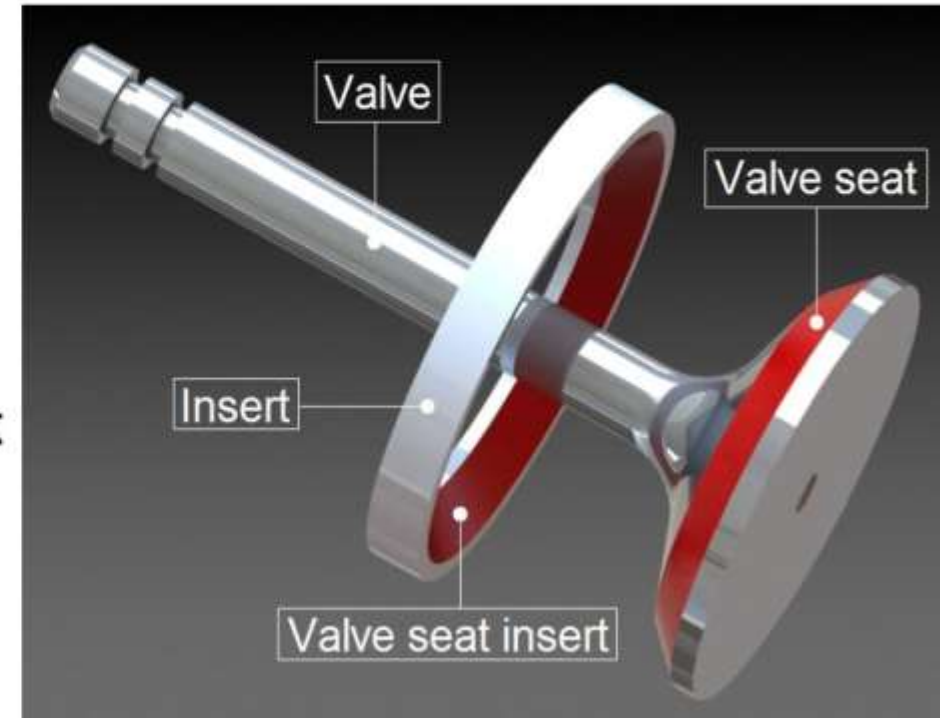
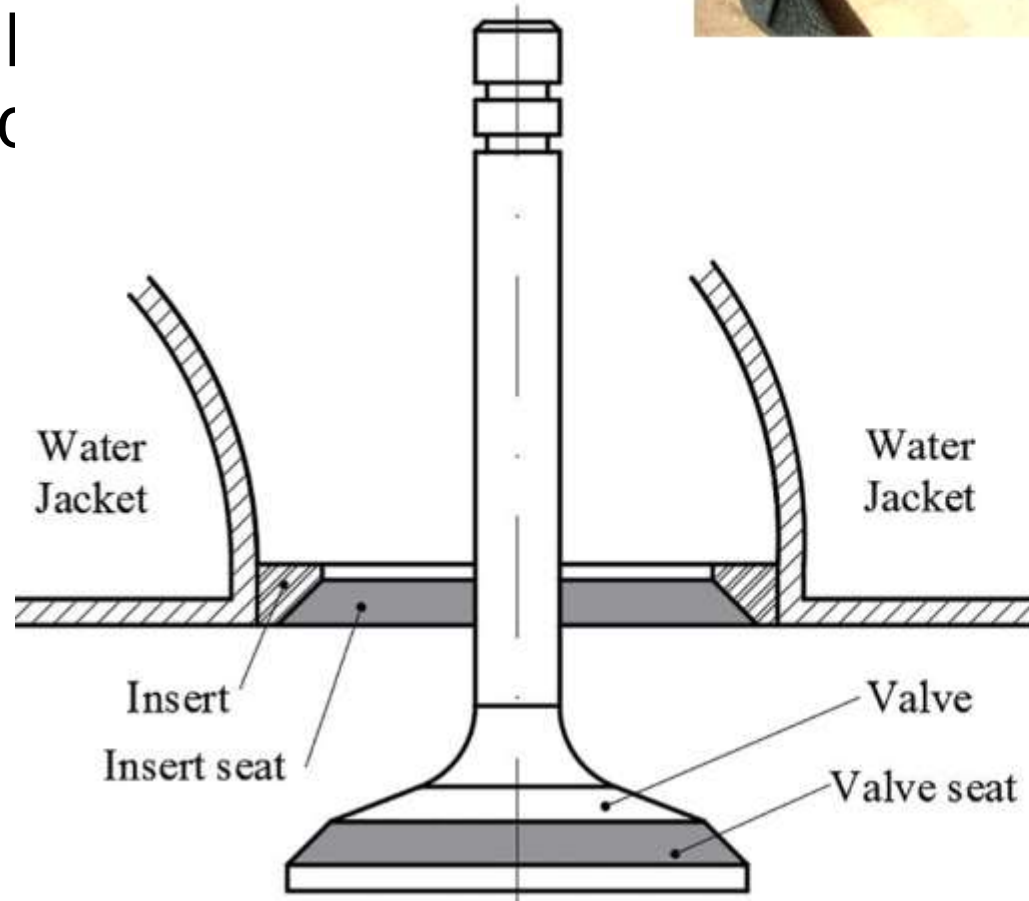
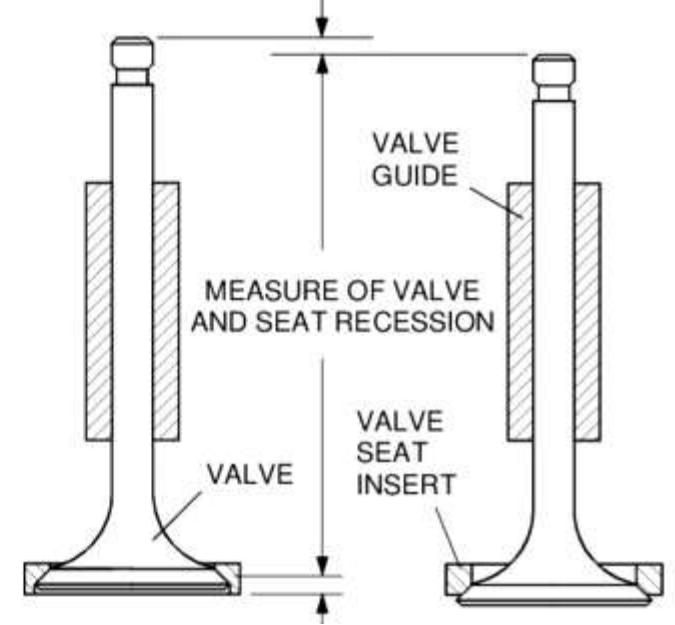
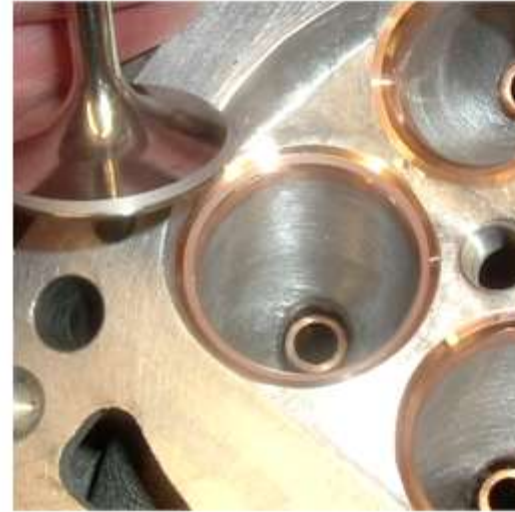
- **dual overhead cam, or twin-cam engine** has two camshafts per bank of the cylinder head, one for the intake valves and another for the exhaust valves. Therefore there are two camshafts for a straight engine and a total of four camshafts for a V engine or a flat engine



- **Valves:** valves act as the doors to the combustion chamber, allowing the fresh mix to flow in during the intake stroke, sealing the chamber during the compression and power strokes, and providing an exit for the spent gas during the exhaust stroke



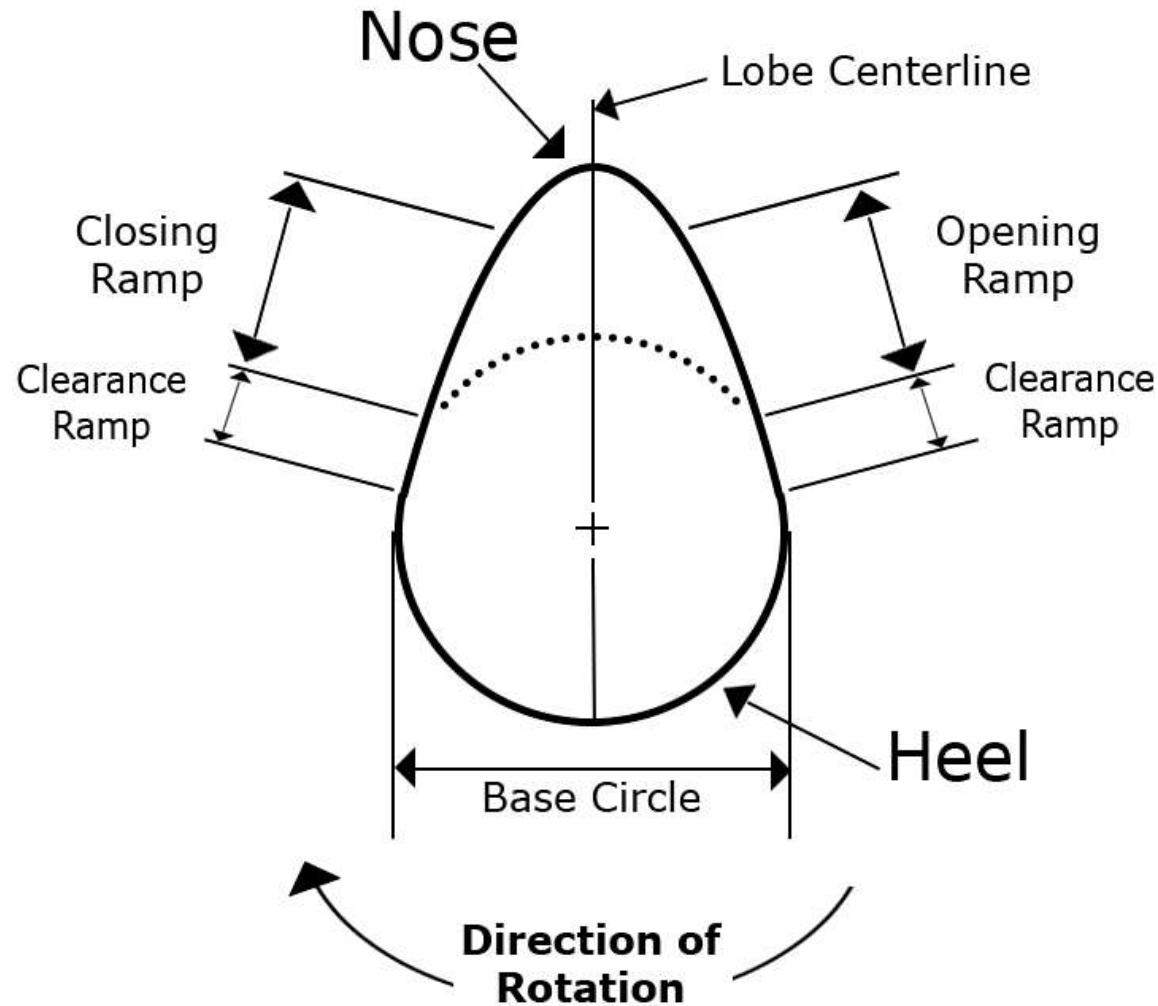
- **Valve Seat Insert:**
transfer heat from the valve to cylinder head, mate with the valve to seal combustion pressure, and provide durable wear for both valve and



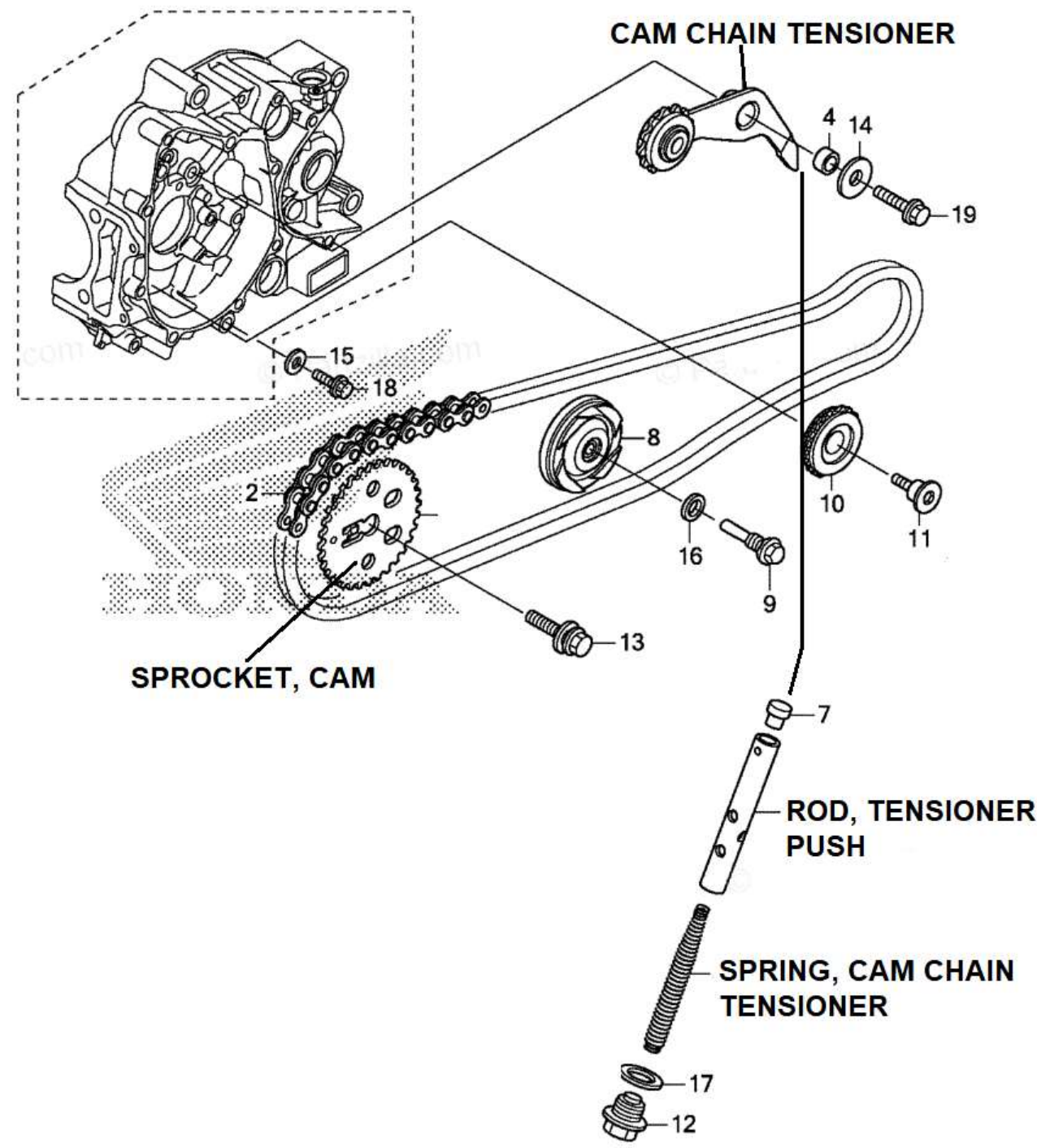
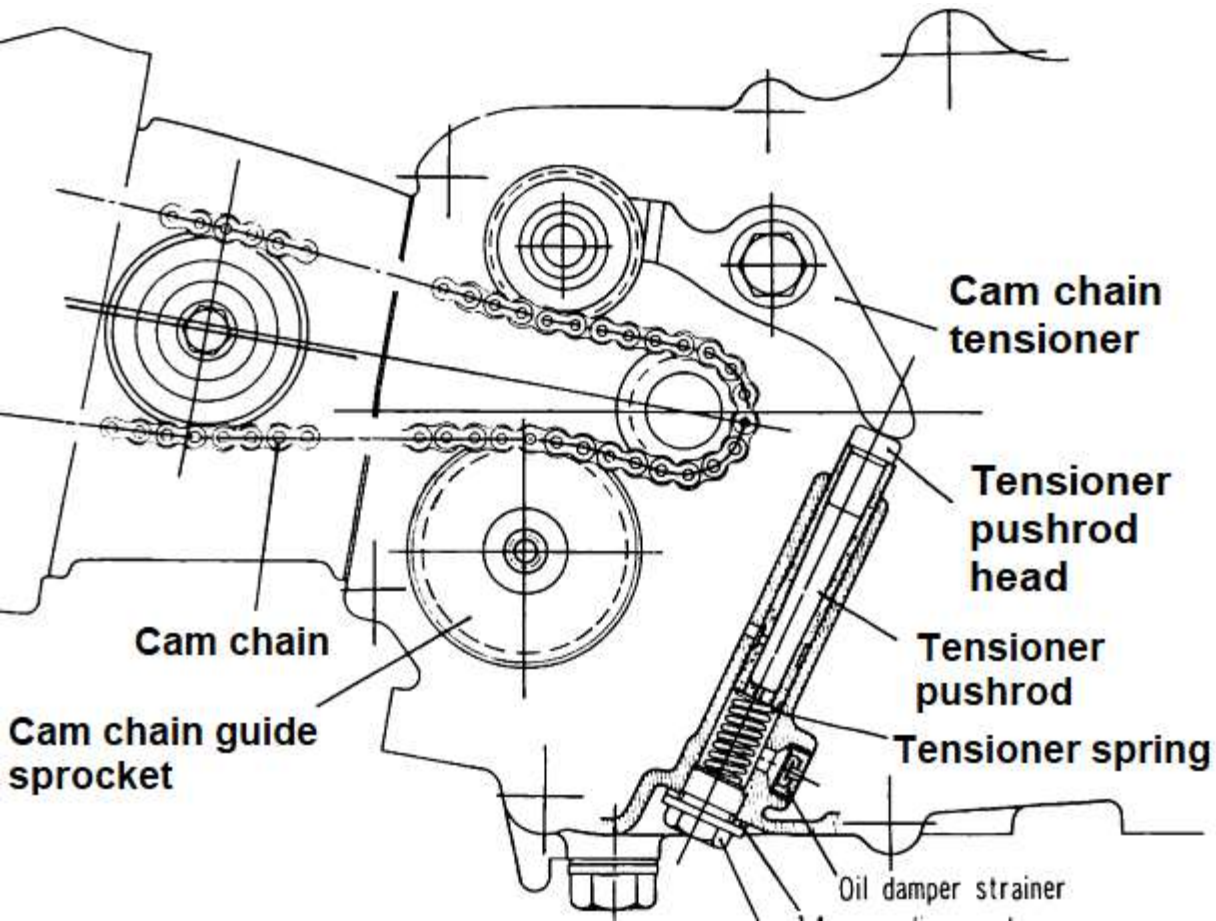
- **Valve Spring:** A valve spring is placed around the stem of a valve and held in place by a retainer. Its main job is to control the entire valvetrain, ensuring that the proper amount of spring pressure is applied consistently to prevent valve bounce

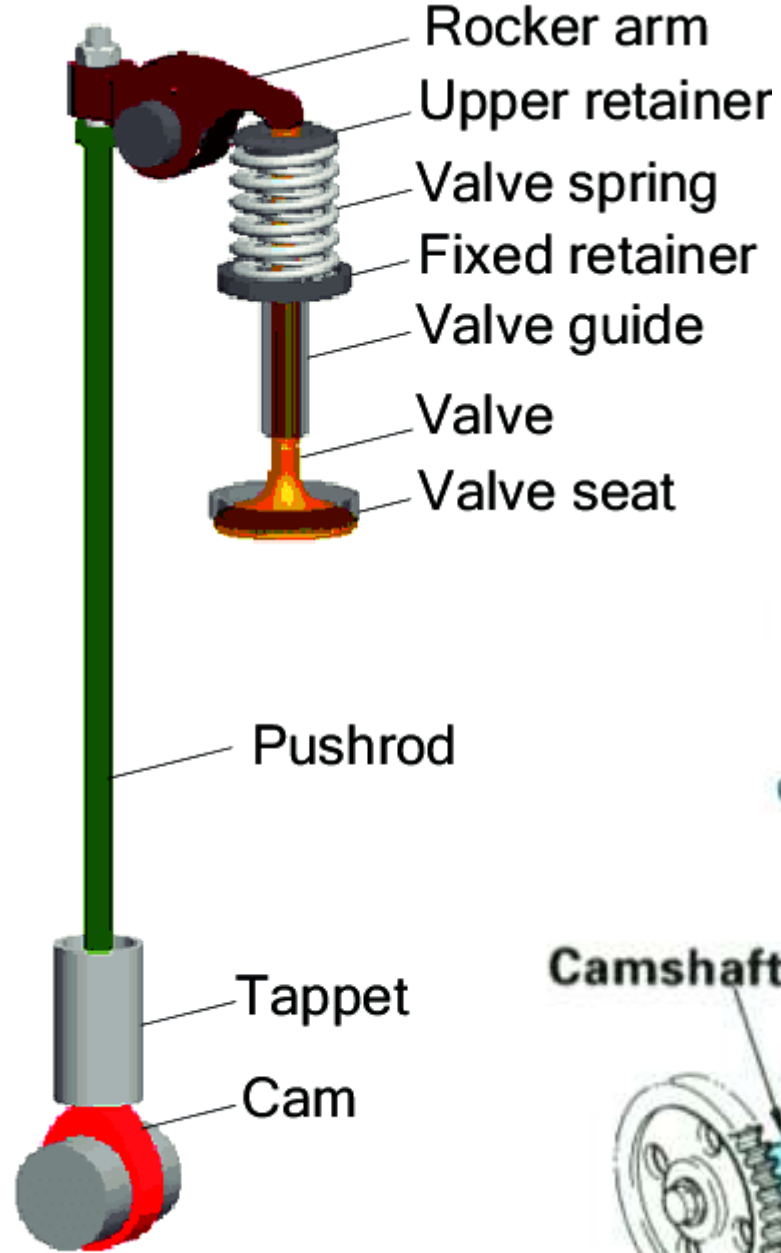


- **Camshaft** is a device that controls both the input of fuel and the expulsion of exhaust fumes. It consists of several radial cams, each displacing intake or exhaust valves. This camshaft is connected to the crankshaft via belt, chain or gears.

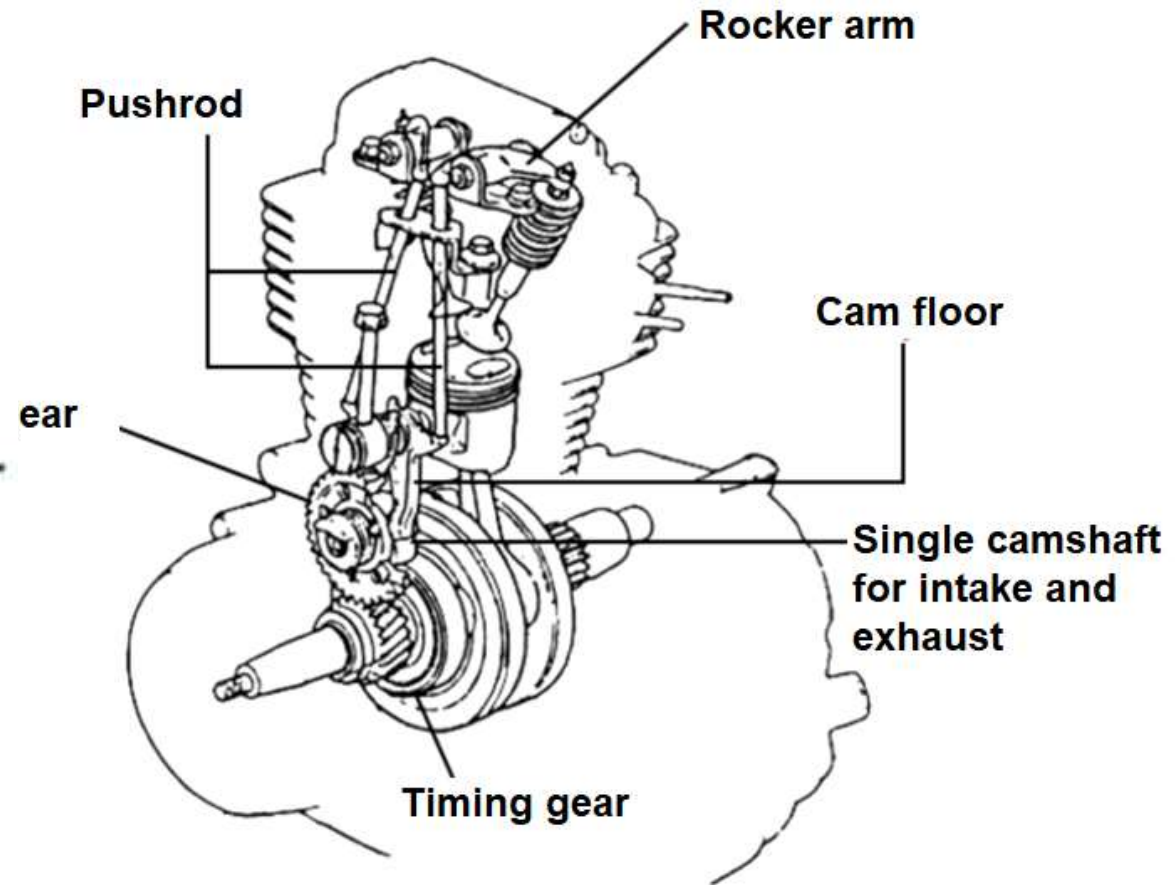
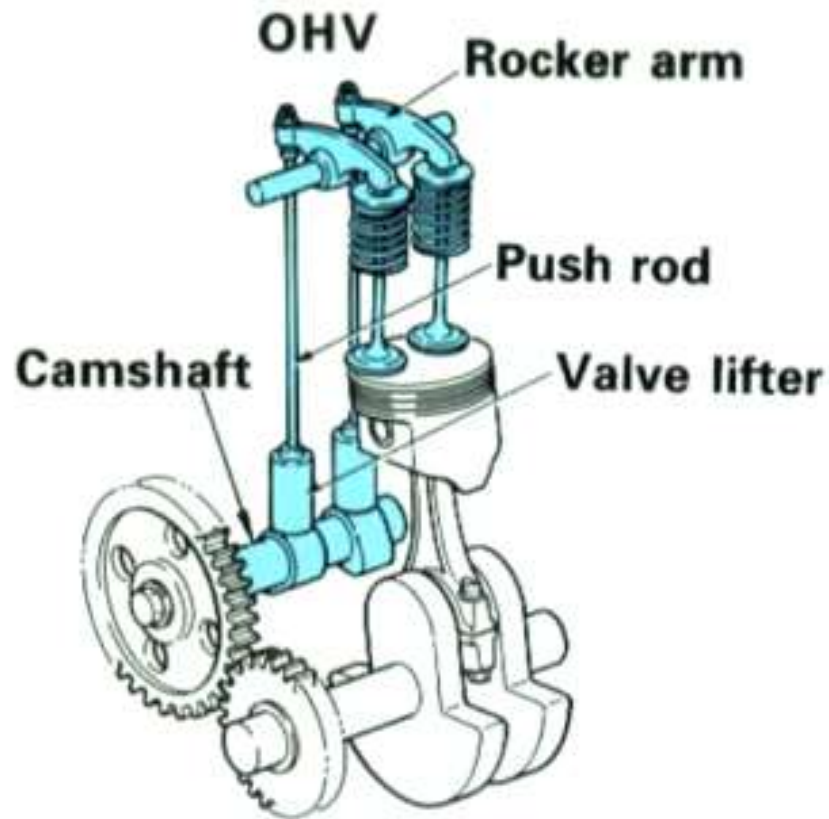


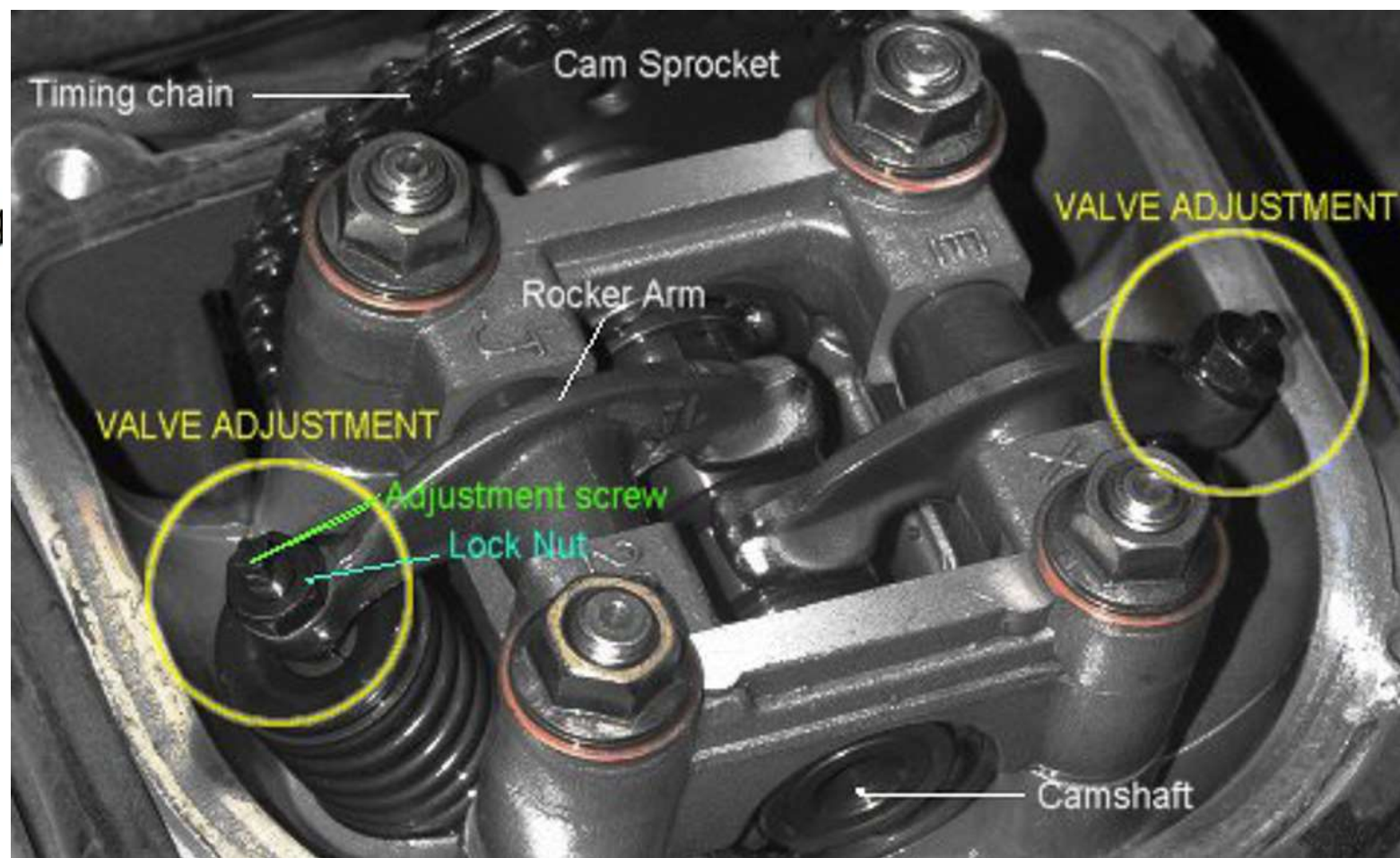
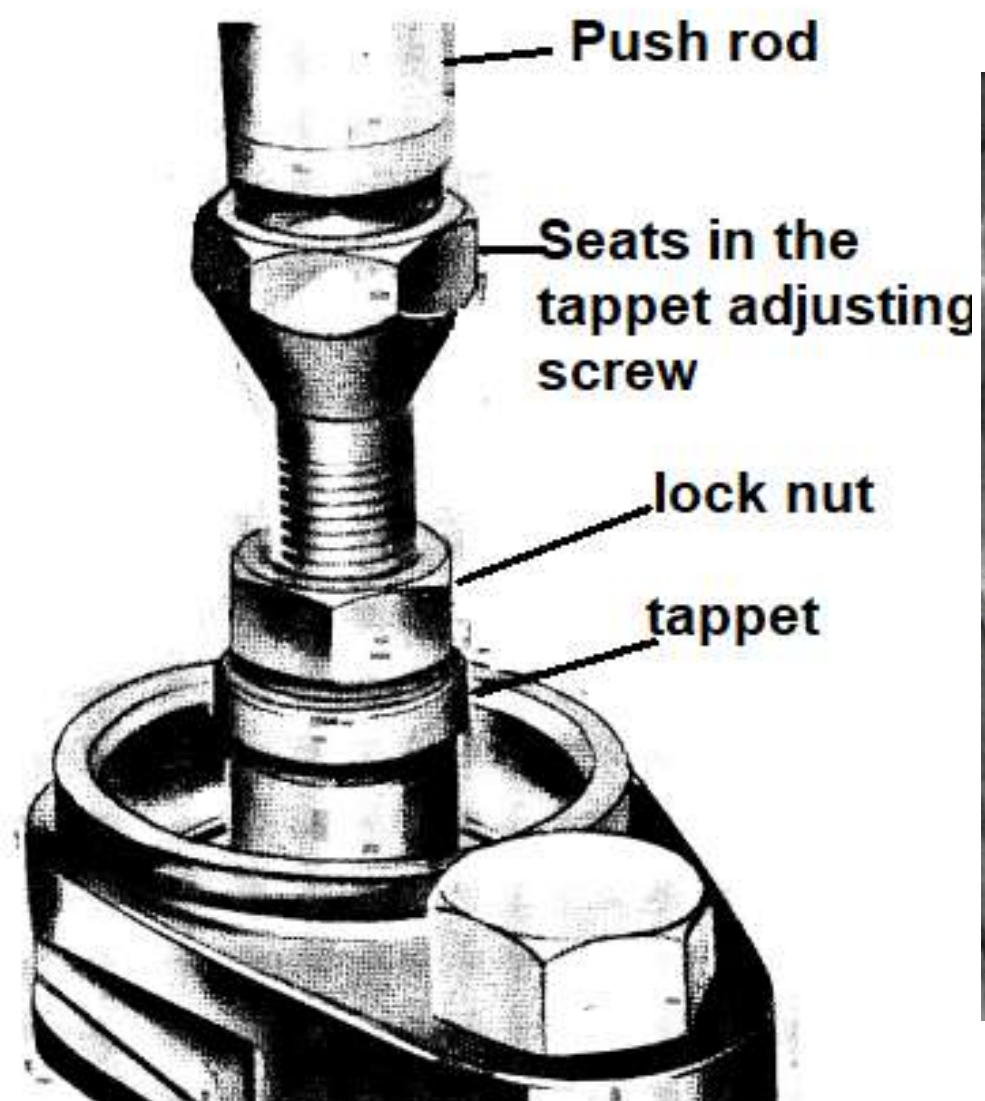
- **Cam chain tensioner** ensures the correct and necessary tension of the timing chain that surrounds the crankshaft sprocket and the camshaft sprocket. It exerts full control, making the chain run smoothly, preventing it from rattling and coming off the sprocket



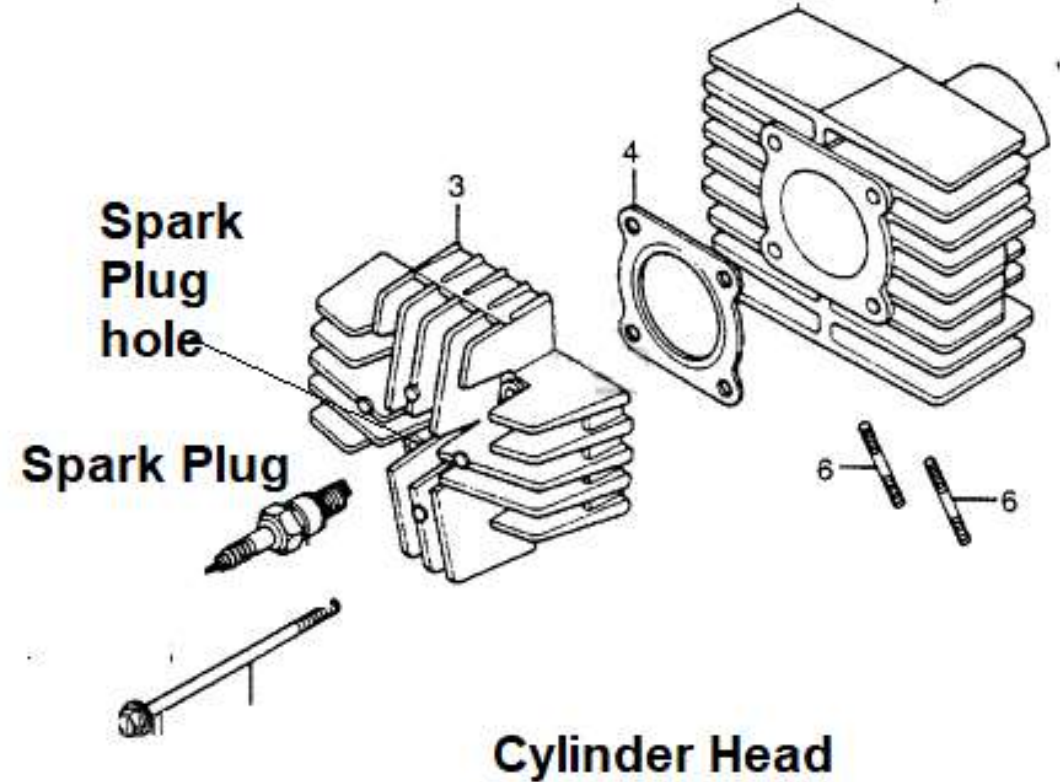
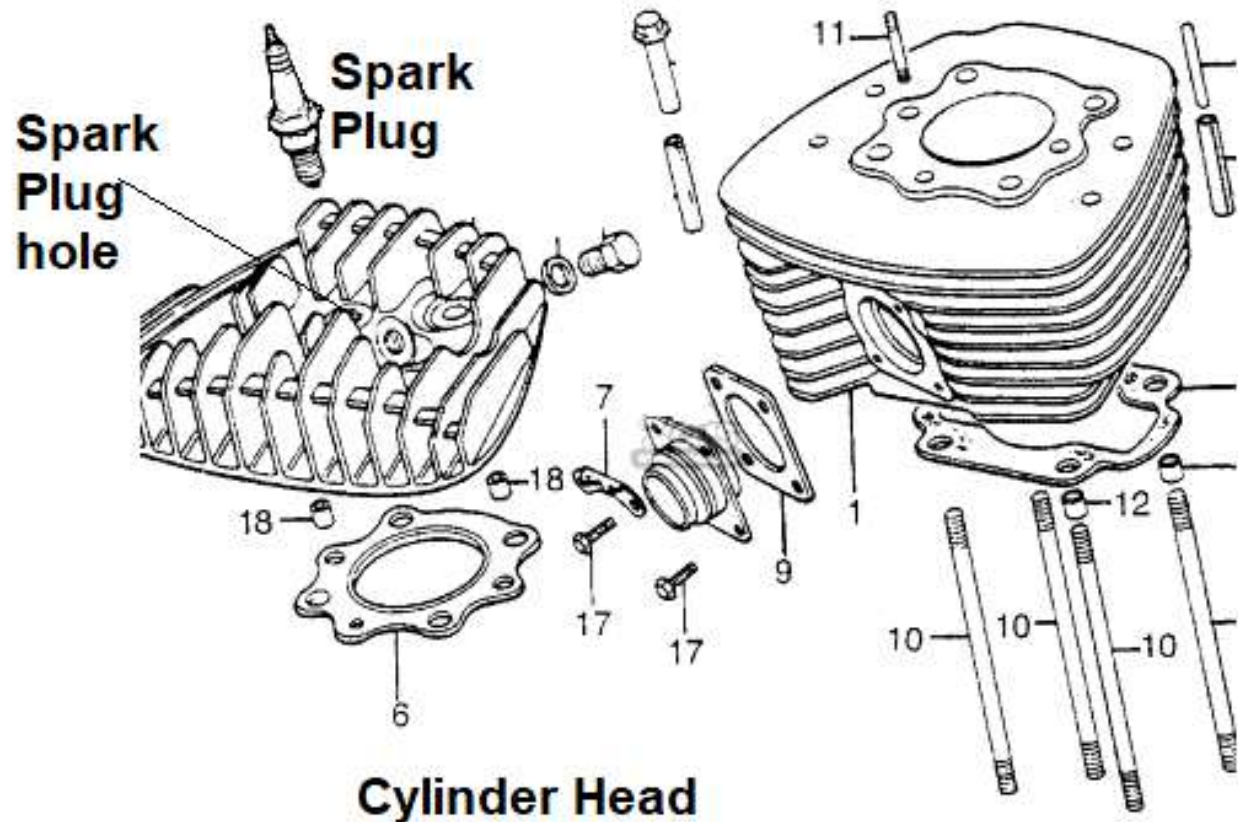


- **Pushrod** With the reciprocating motion of the camshaft, the Pushrod on the outer valve rotates; its motion pivots the outer rocker arm and pushes the outlet valve inside, thus closing it and opening the inlet valve.

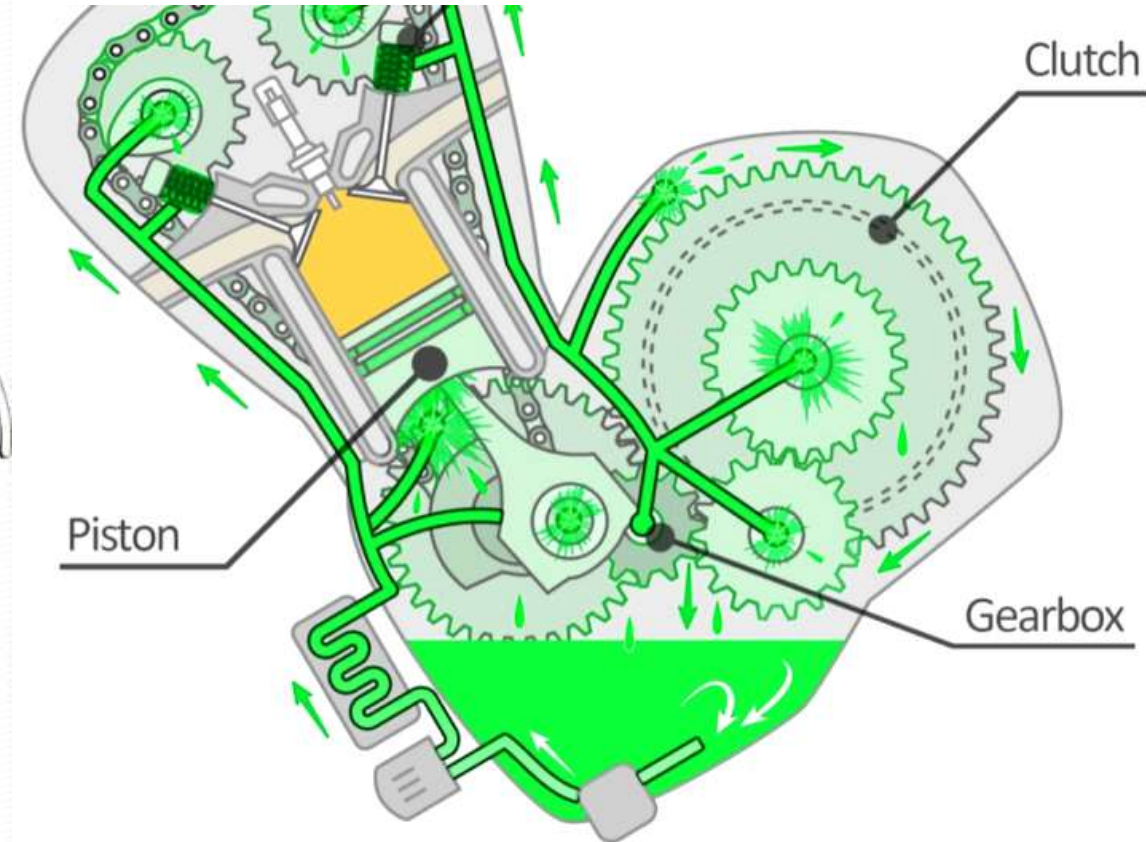
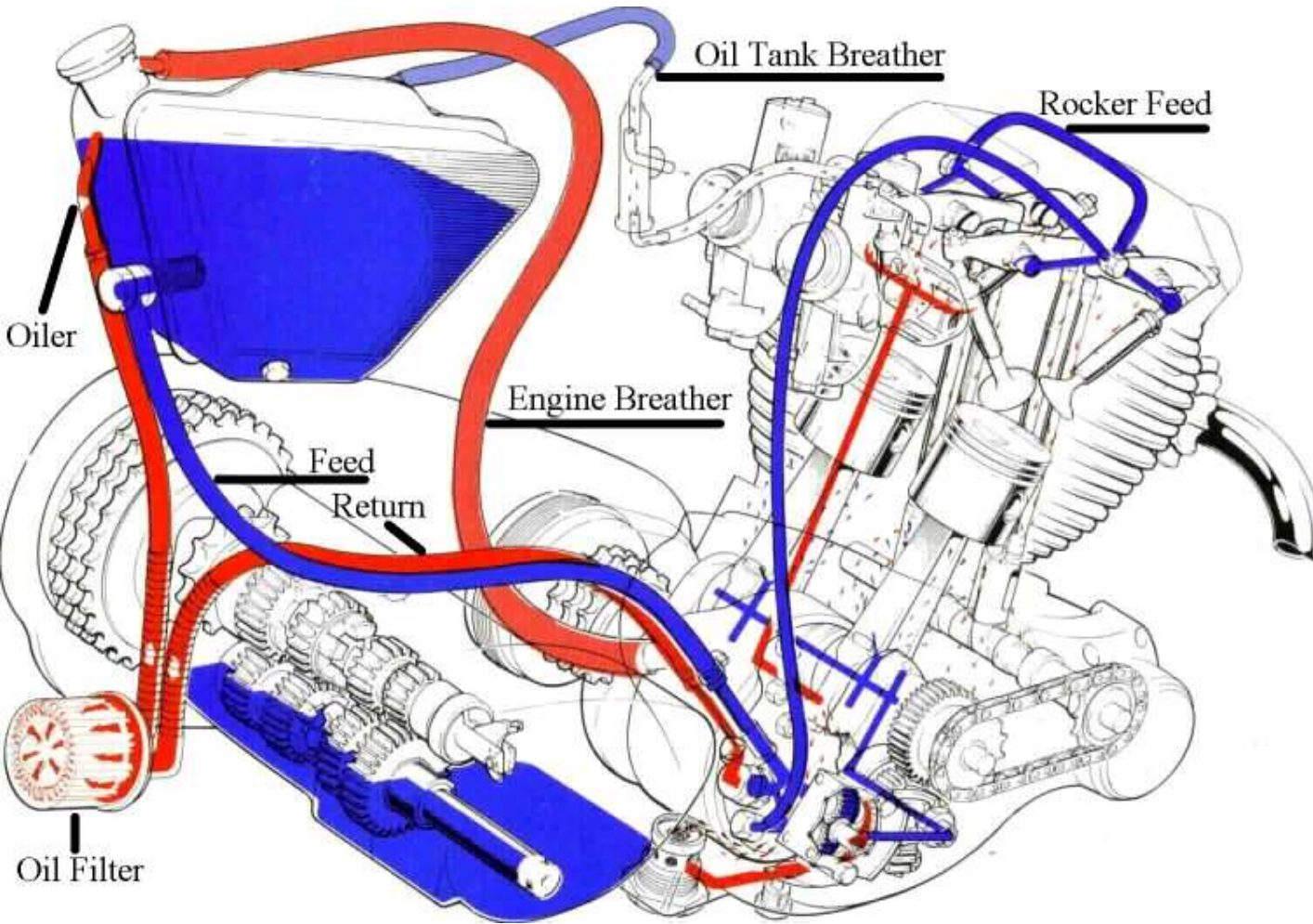




- The **Spark Plug hole** is the part where the spark plugs usually screw into in the cylinder head.

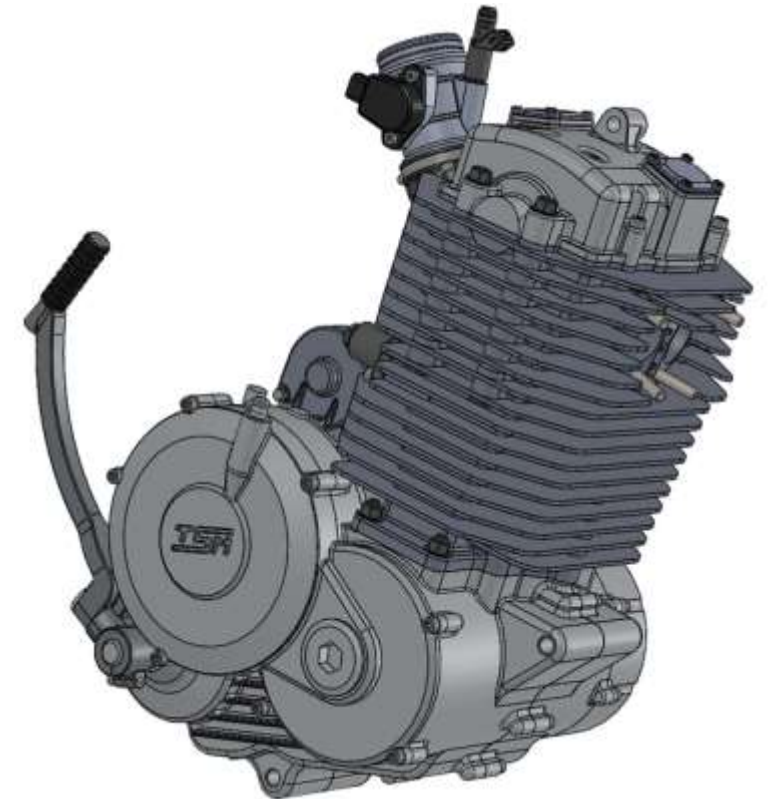
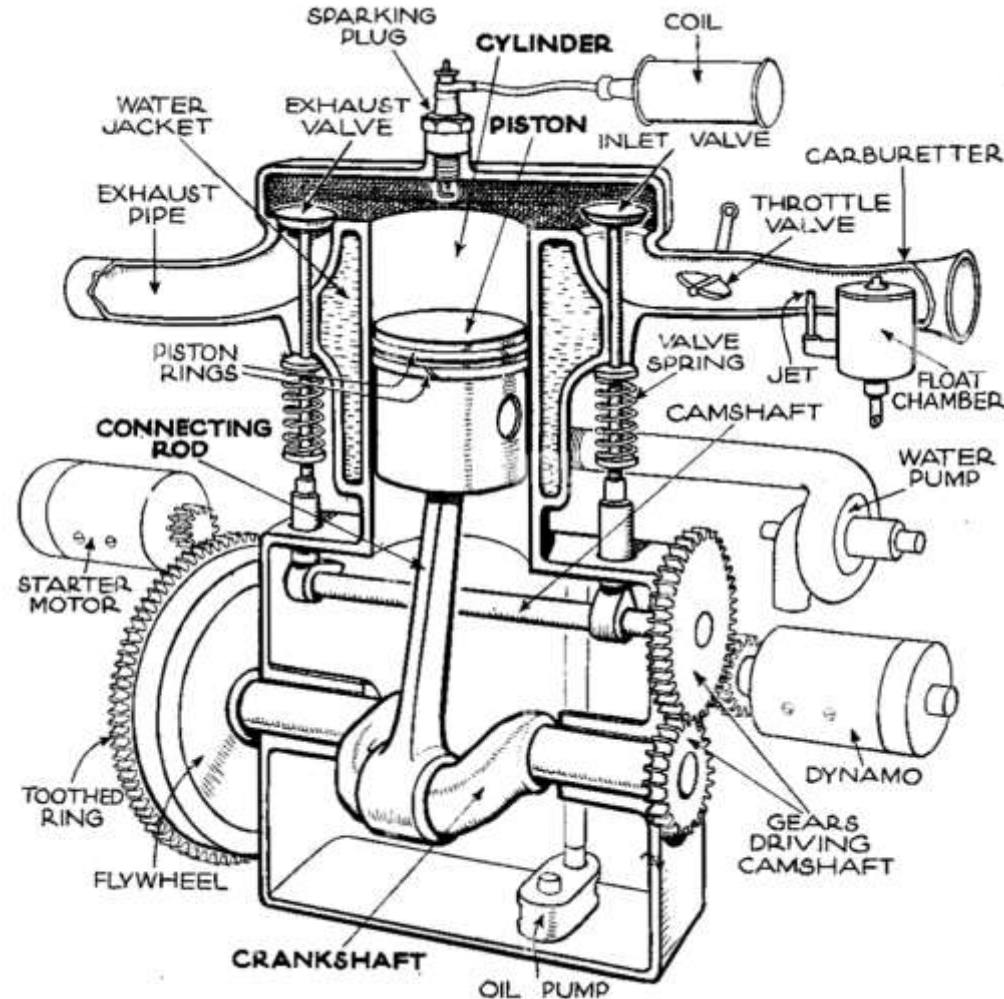


Lubrication Provision

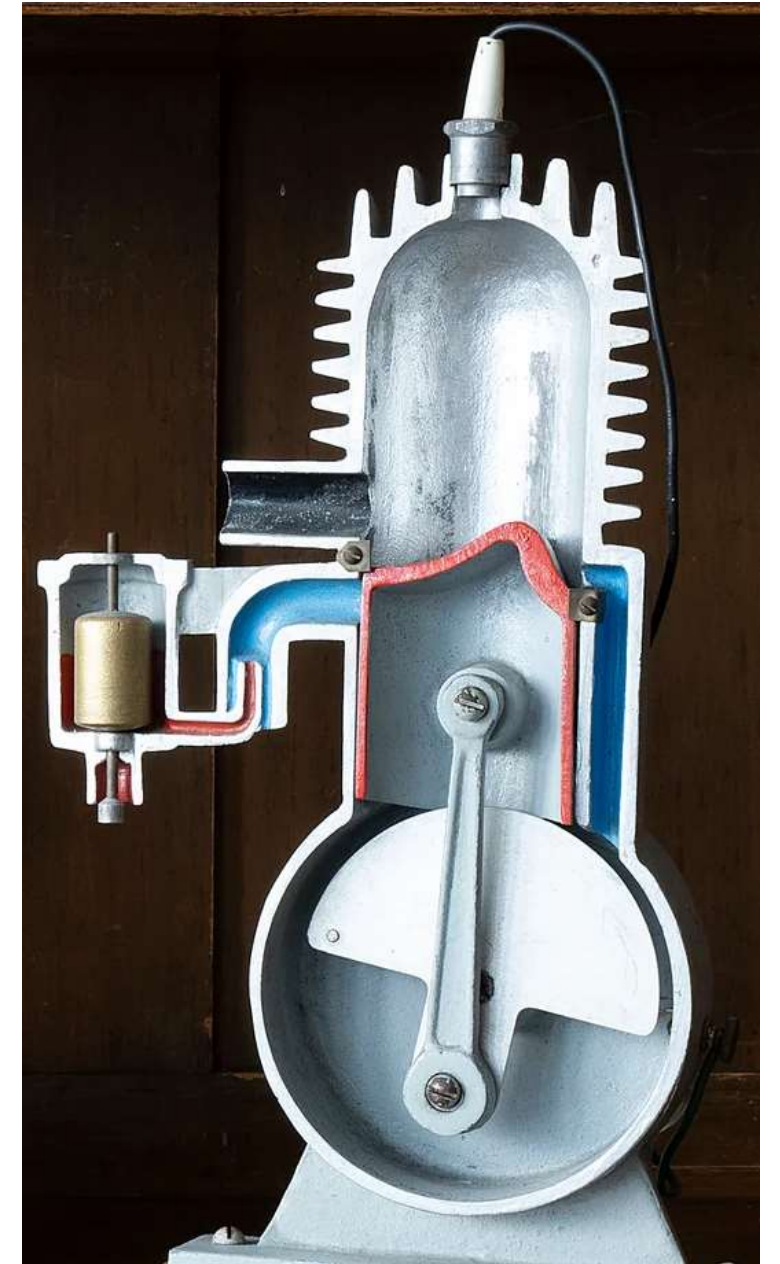


Single Cylinder Lower End

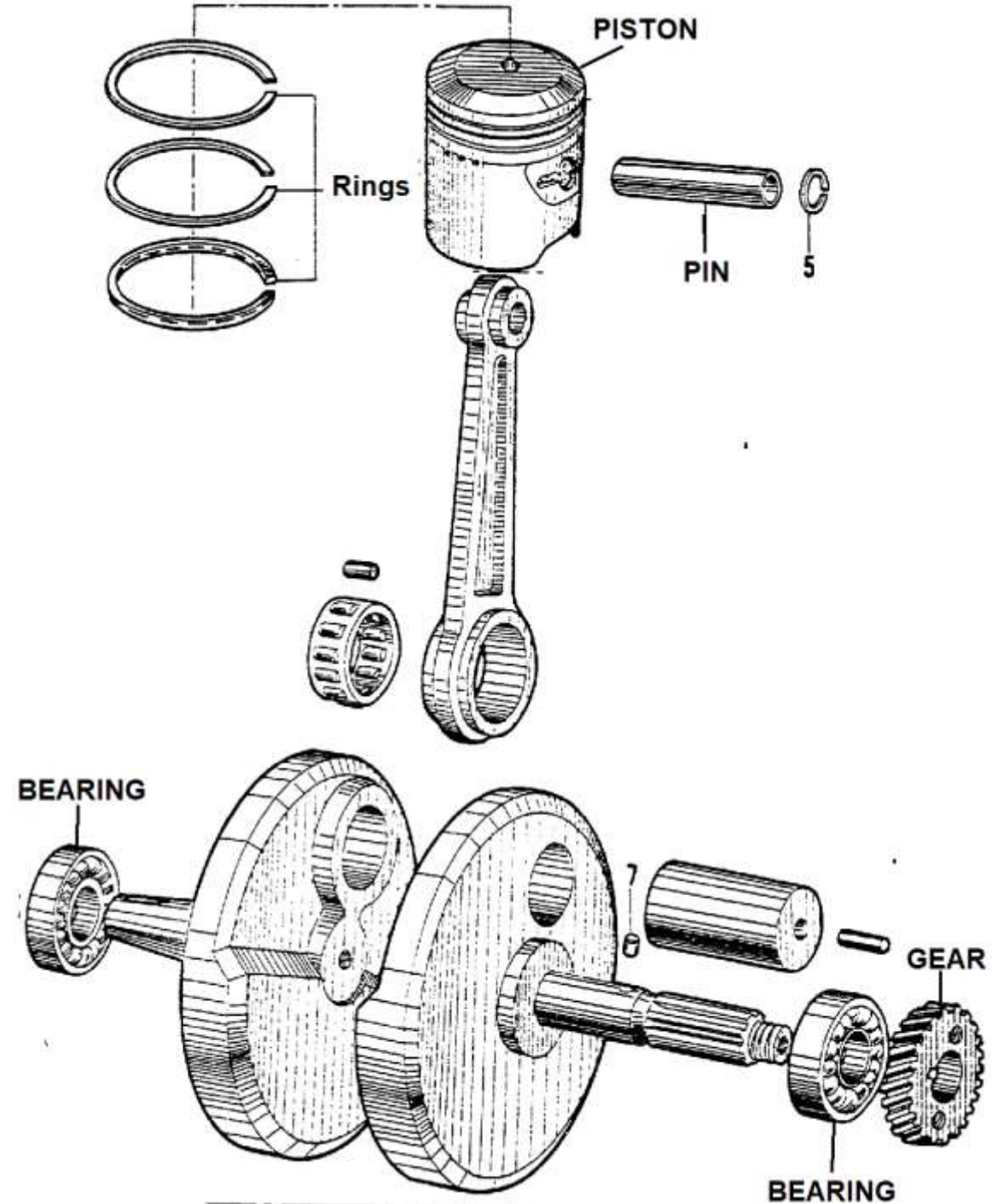
- The **crankcase** is the housing that surrounds the crankshaft. In most modern engines, the crankcase is integrated into the engine block.

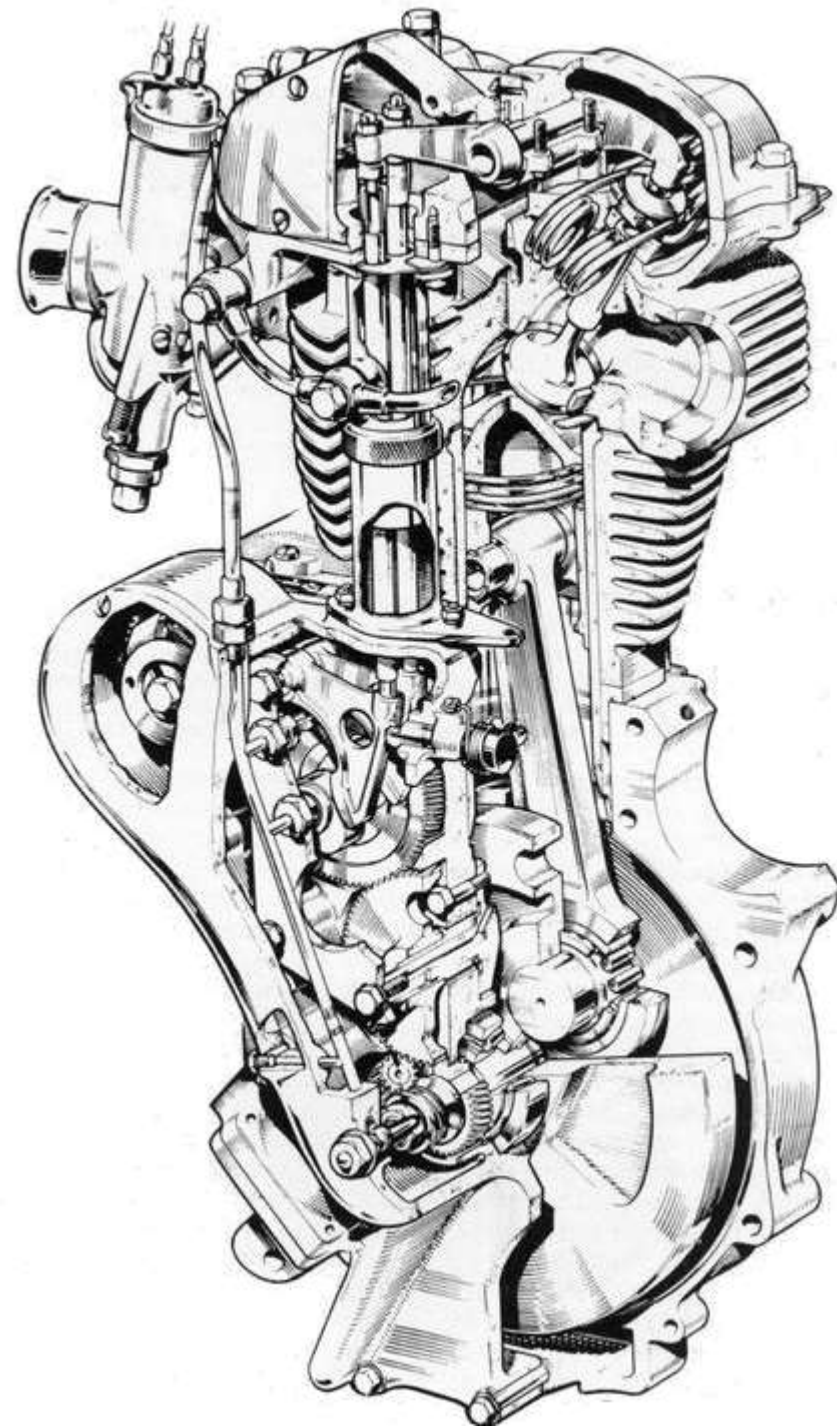
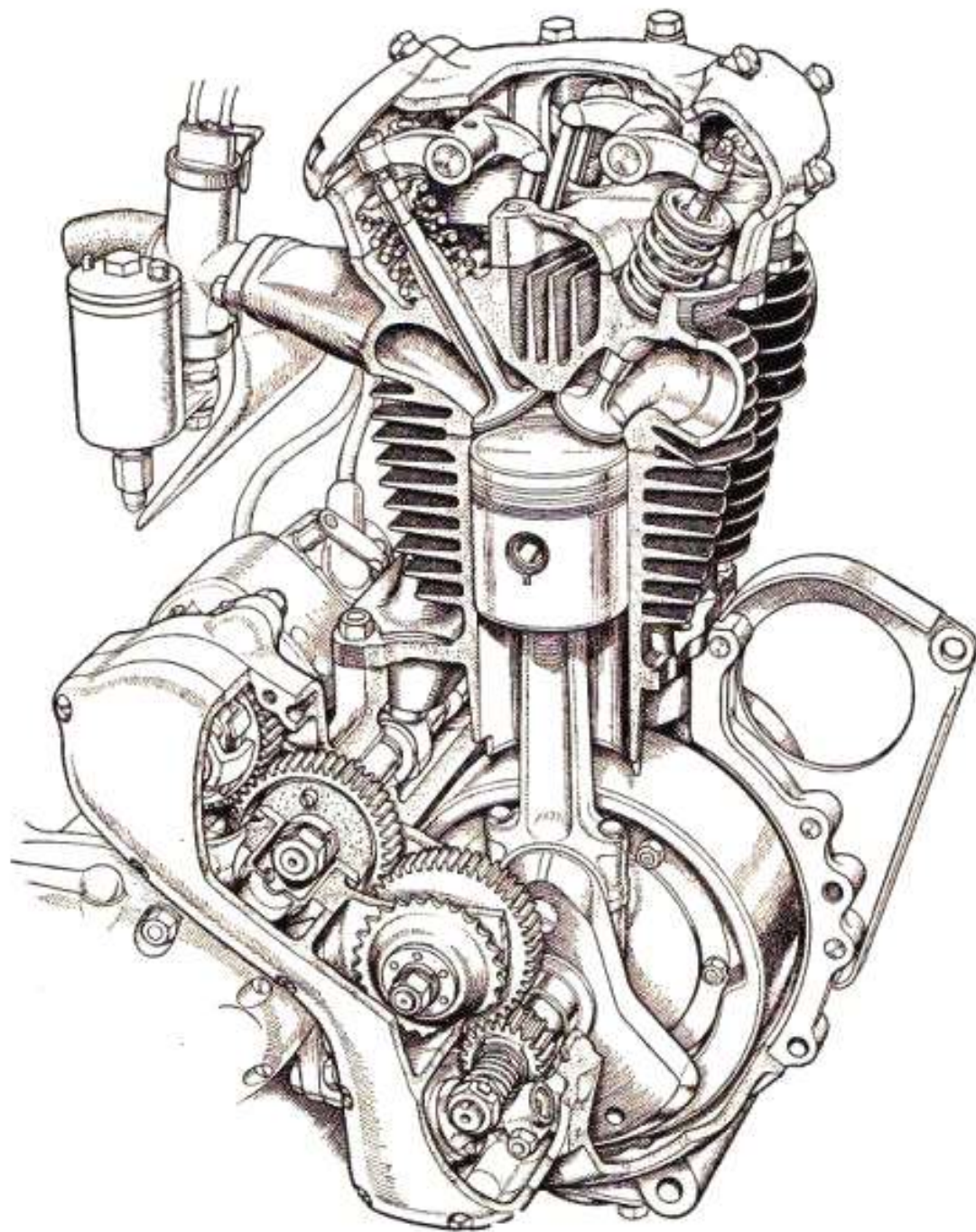


- Two-stroke engines typically use a crankcase-compression design, resulting in the fuel/air mixture passing through the crankcase before entering the cylinder(s). This design of the engine does not include an oil sump in the crankcase.

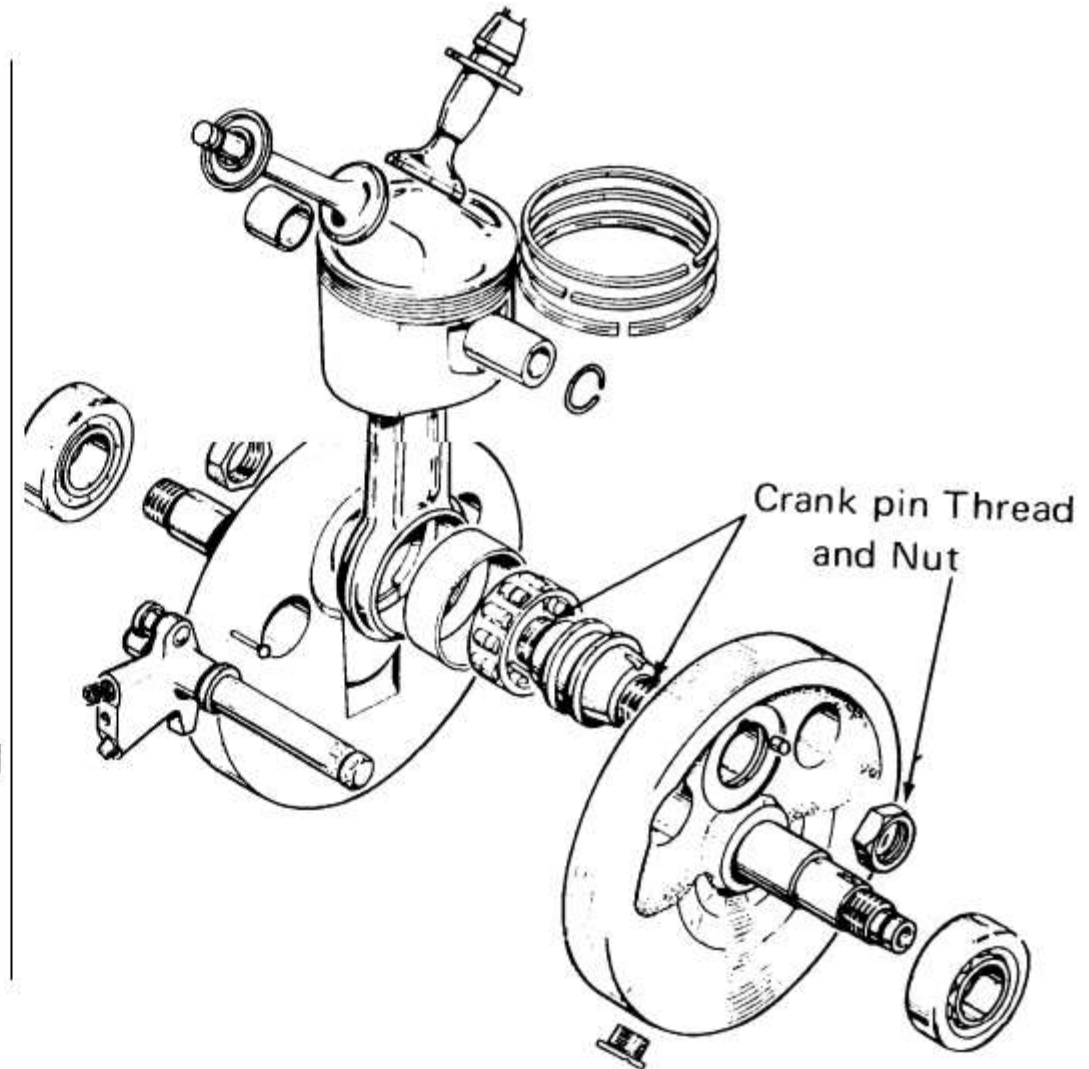
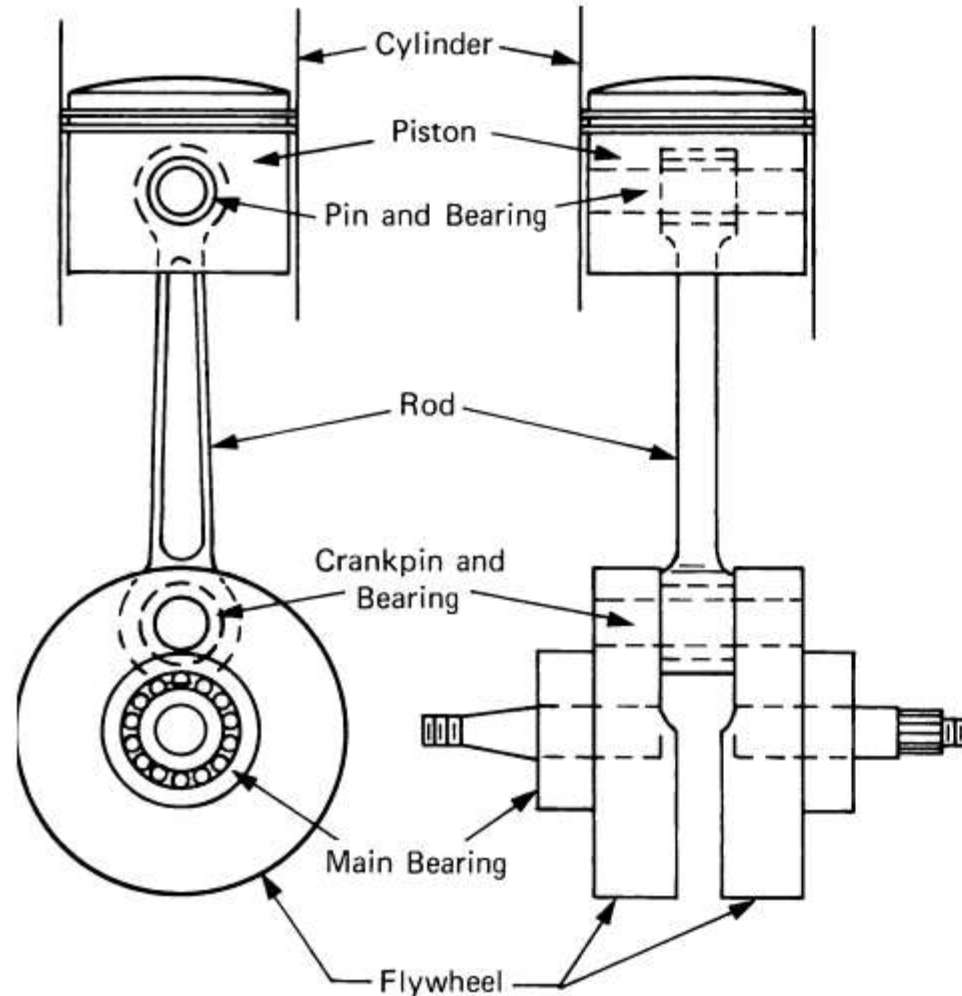


- The crankshaft is essentially the backbone of the internal combustion engine. The crankshaft is responsible for the proper operation of the engine and converting a linear motion to a rotational motion. Crankshafts should have very high fatigue strength and wear resistance to ensure long service life.

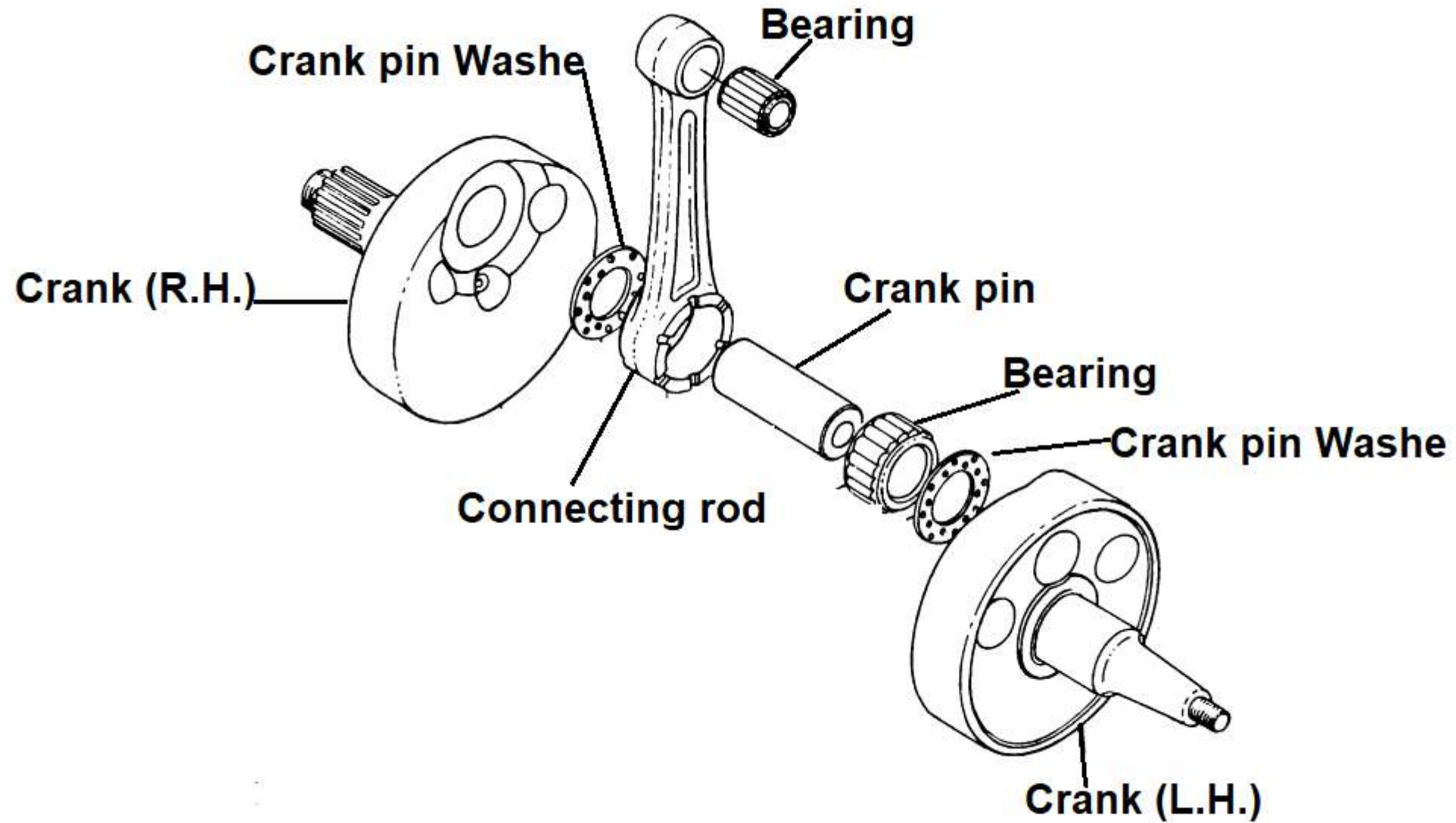




- The crankshaft located within the engine block(Lower End), held in place via main bearings which allow the crankshaft to rotate within the block. The up-down motion of each piston is transferred to the crankshaft via connecting rods. A flywheel is often attached to one end of the crankshaft, in order to smoothen the power delivery and reduce vibration



- **Crankshaft parts**



- The crankcase houses a motorcycle's crankshaft and transmission components. In simple two-stroke engines, the crankcase serves several roles and is used as the pressurization chamber for the fuel-air mixture.





HORIZONTAL



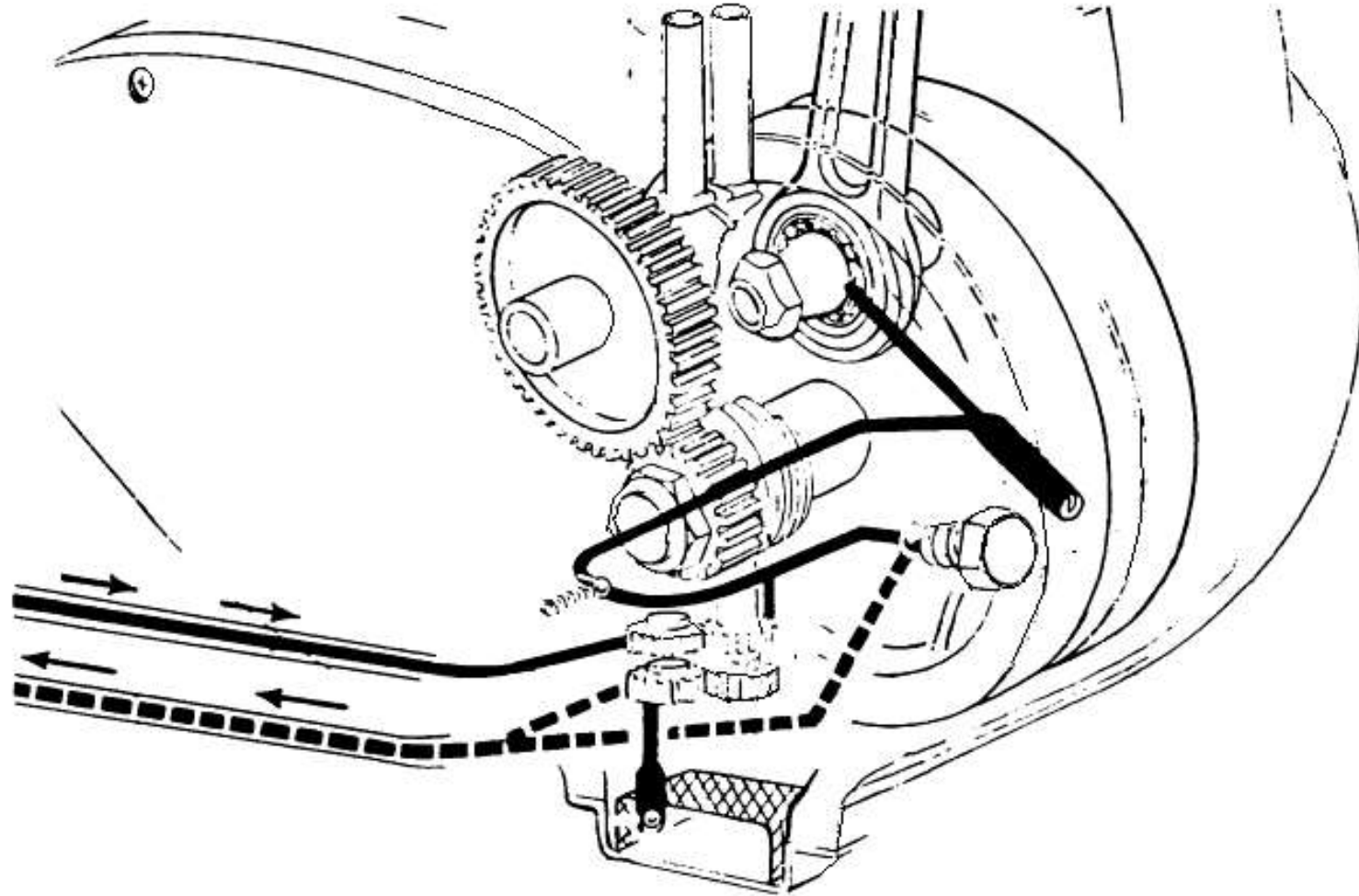
VERTICAL



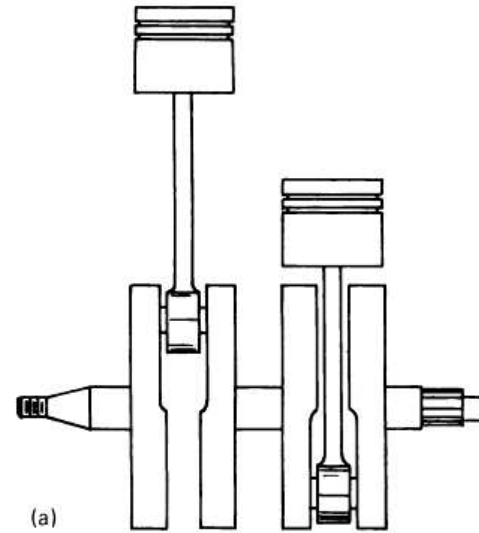
INCLINED



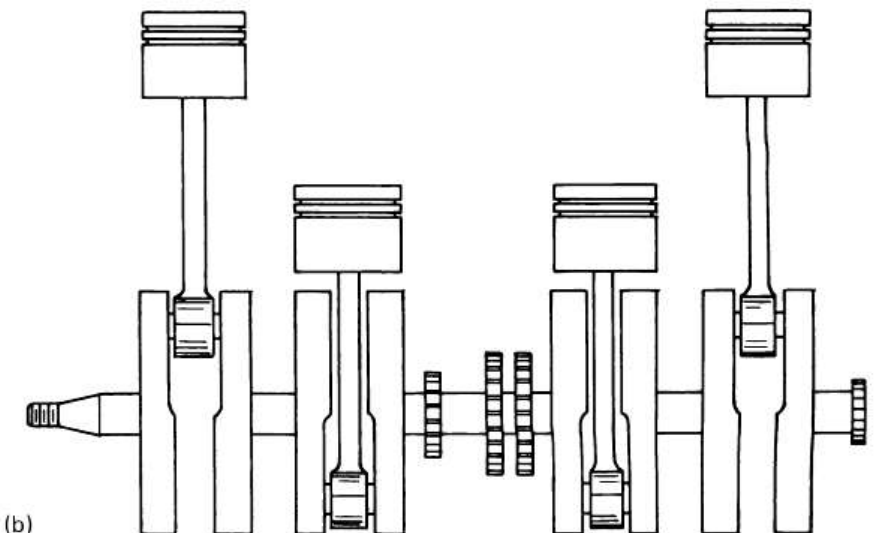
- **Oil Passages in Crank**



Multi Cylinder Lower End



(a) TWO-STROKE TWIN



(b) 4-STROKE FOUR CYLINDER





Single



Parallel-Twin



Inline-Three



Inline-Four



V-Twin



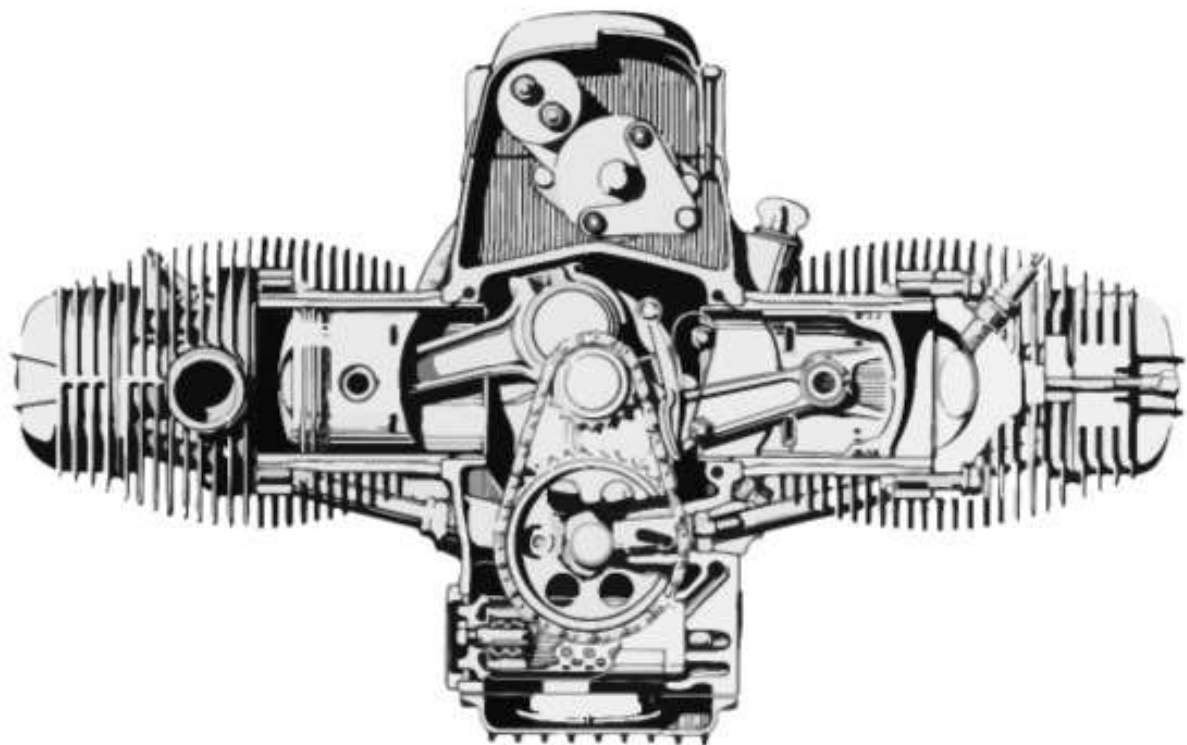
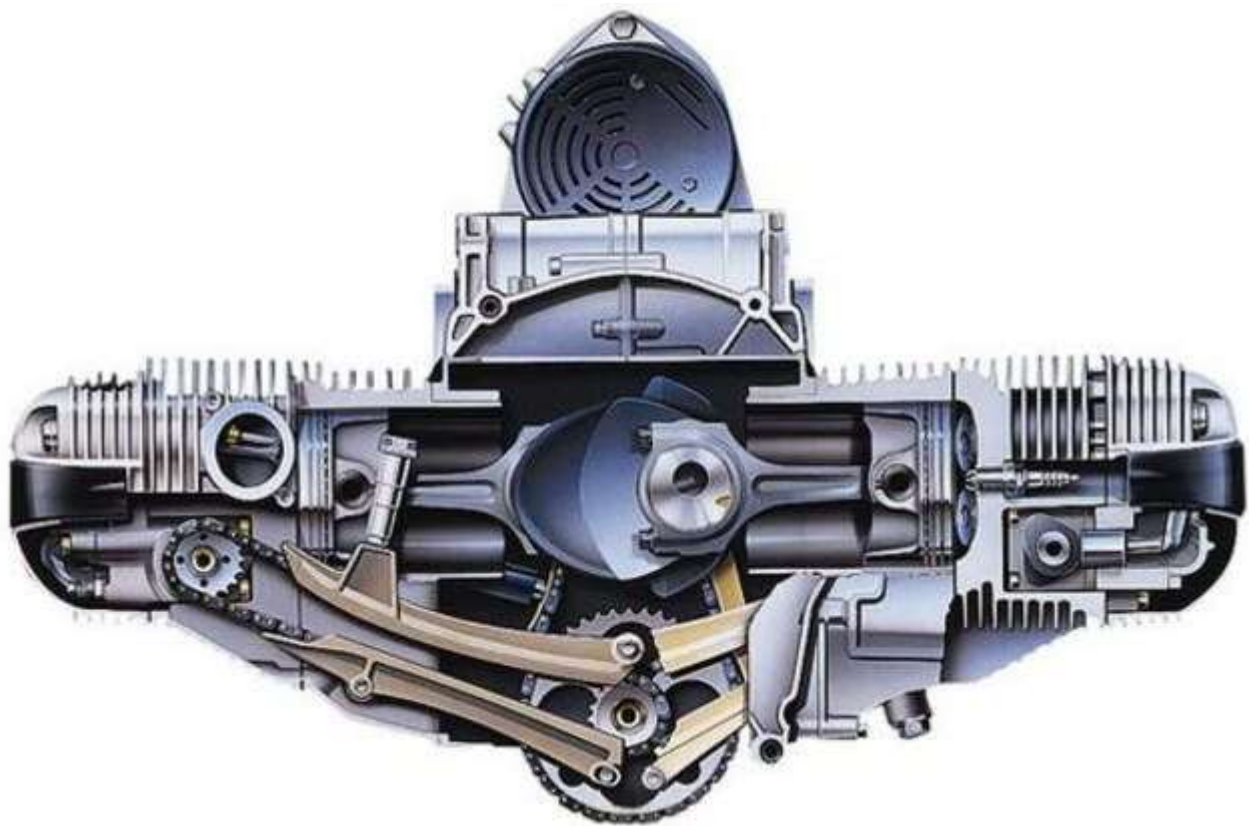
L-Twin



V4

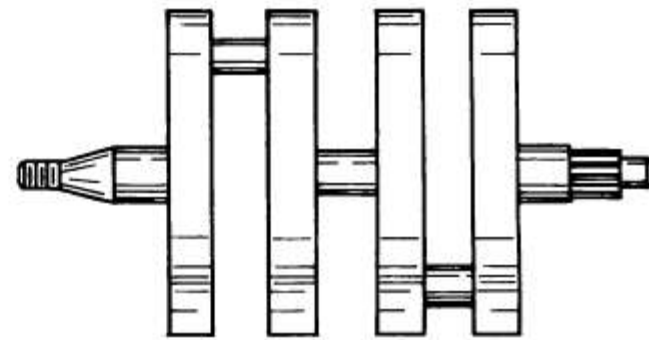


Flat-Twins (Boxer)

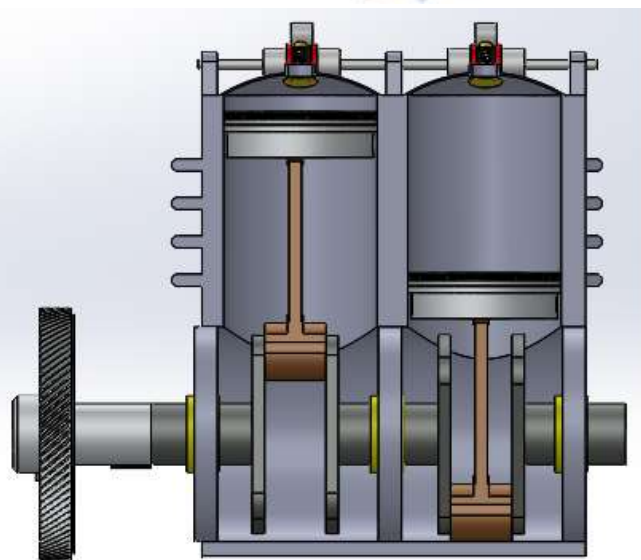




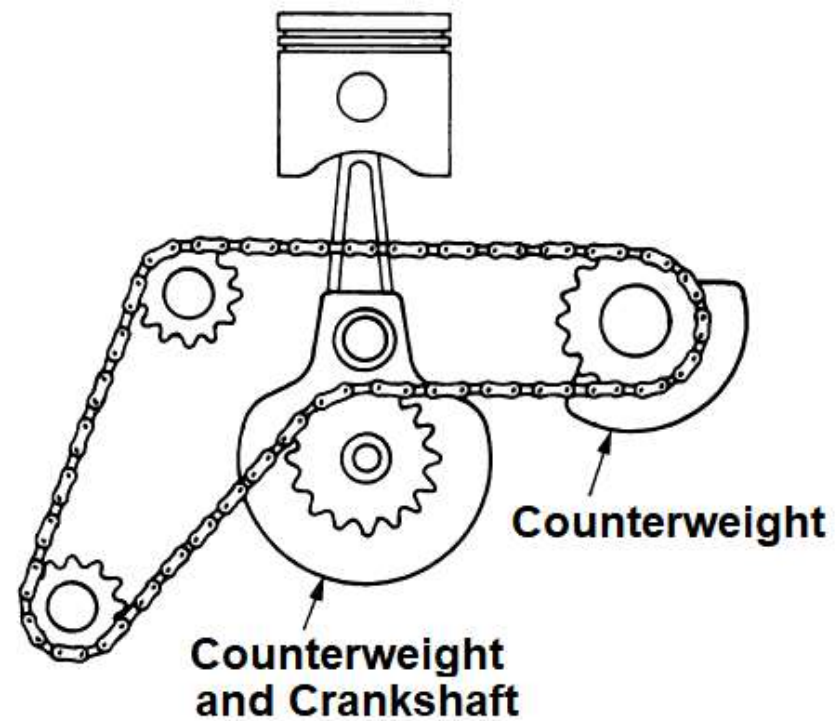
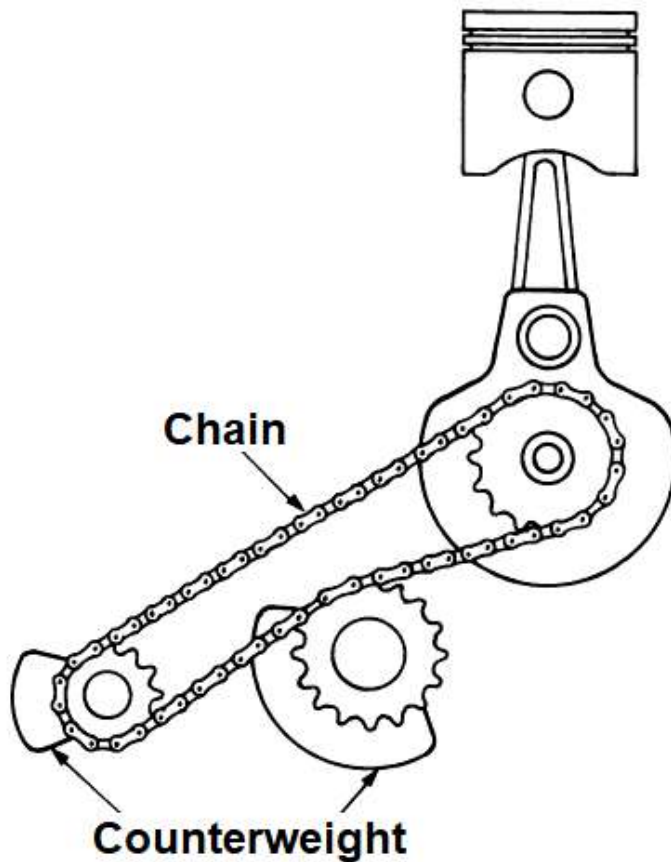
4-STROKE 360° TWIN



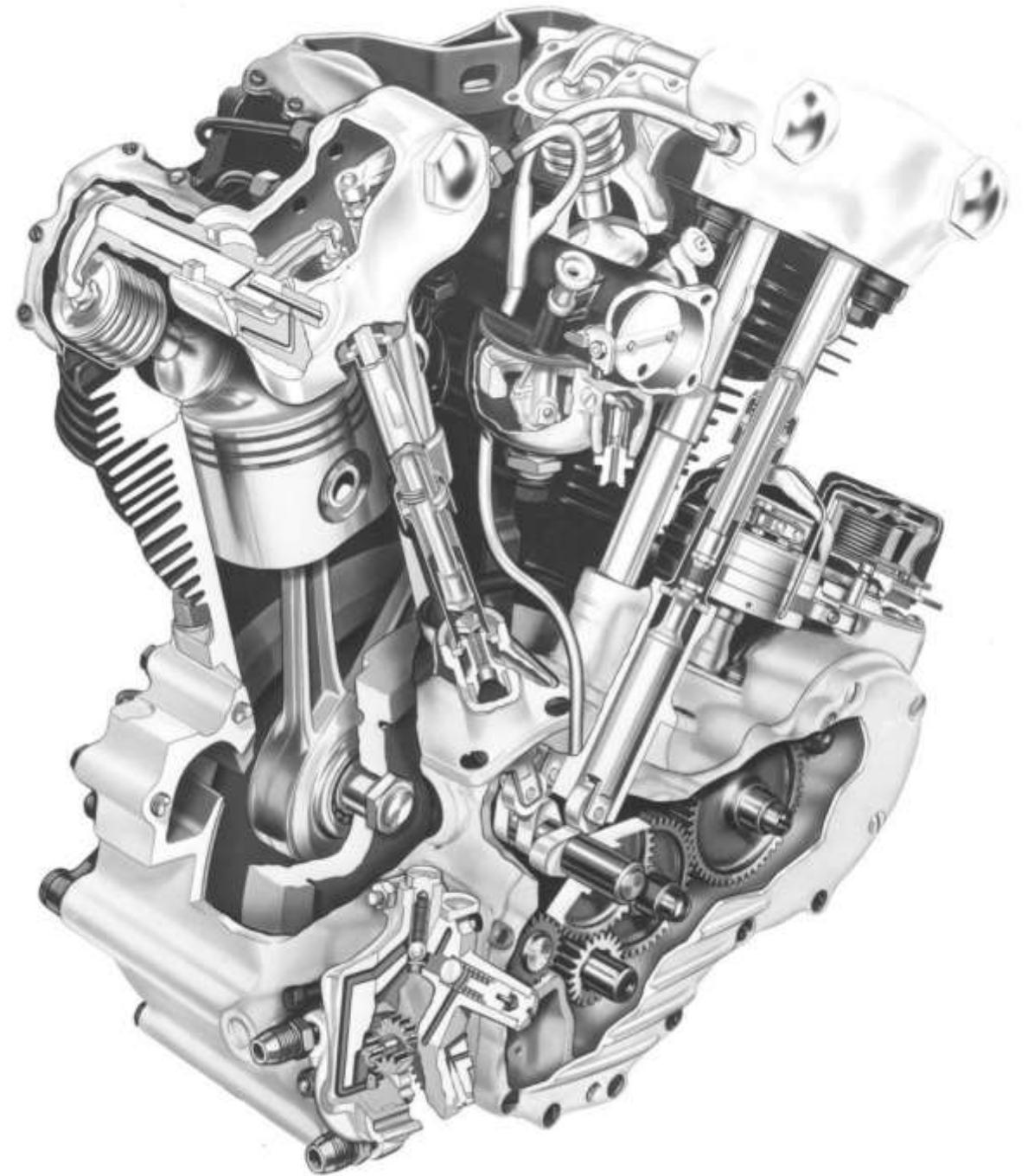
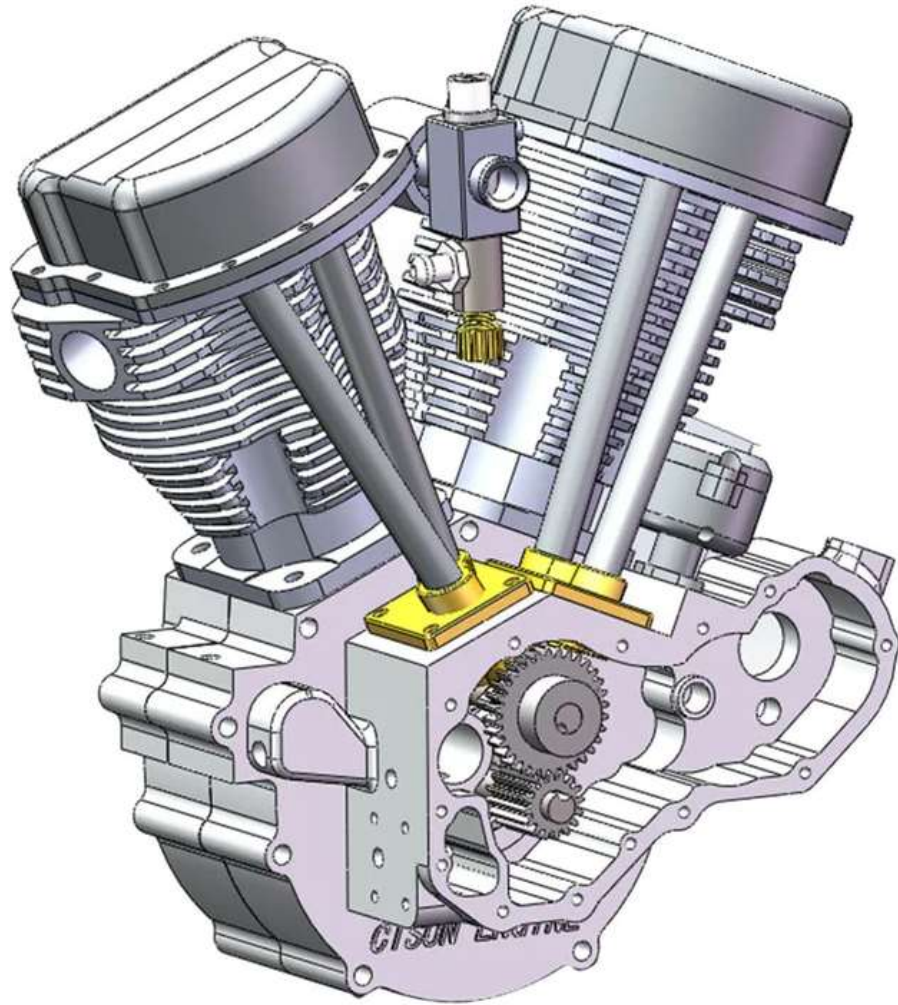
4-STROKE 180° TWIN



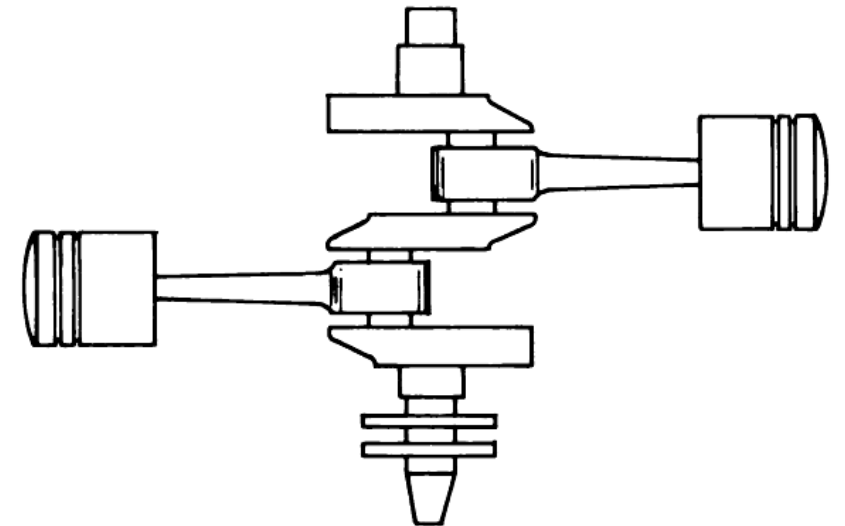
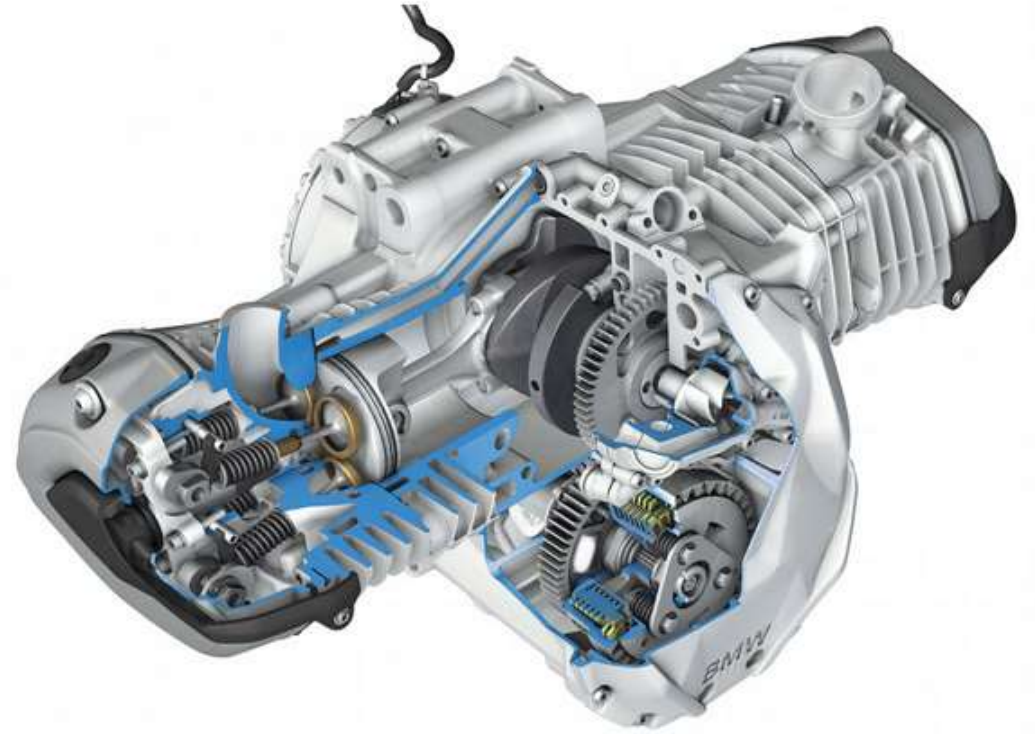
Four stroke twin 180



- A **V-twin engine**, also called a **V2 engine**, is a two-cylinder piston engine where the cylinders are arranged in a V configuration and share a common crankshaft.

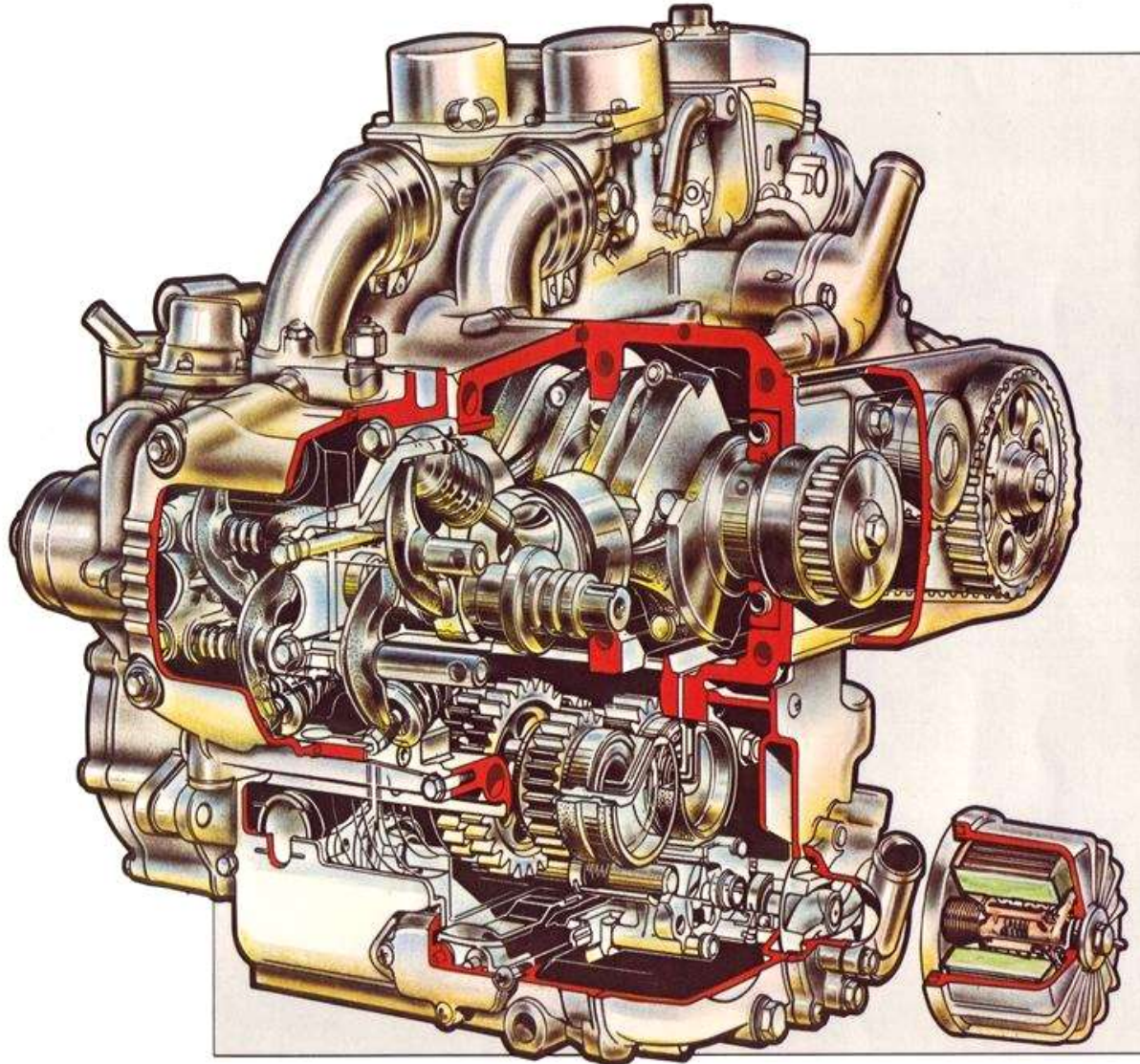


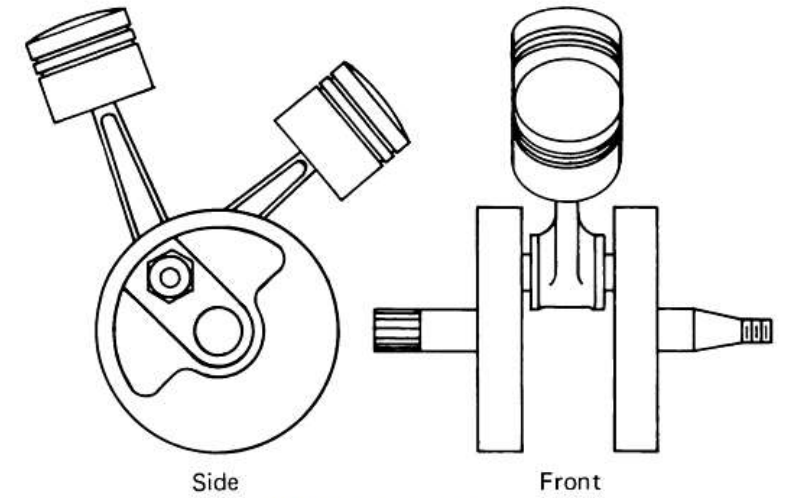
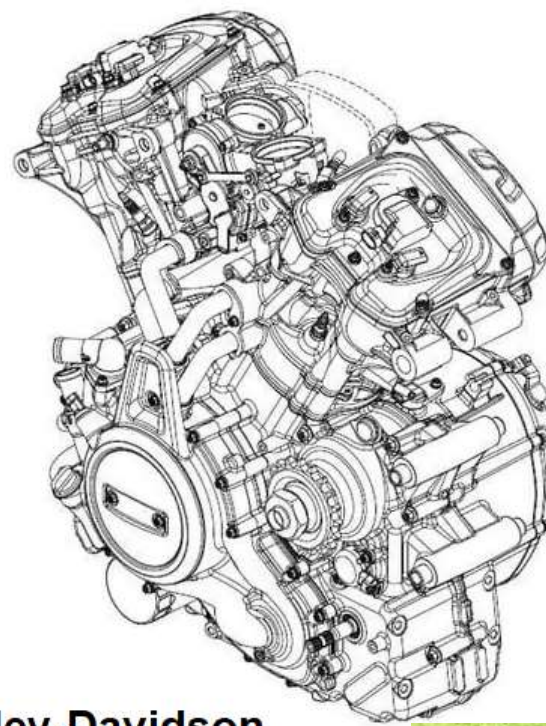
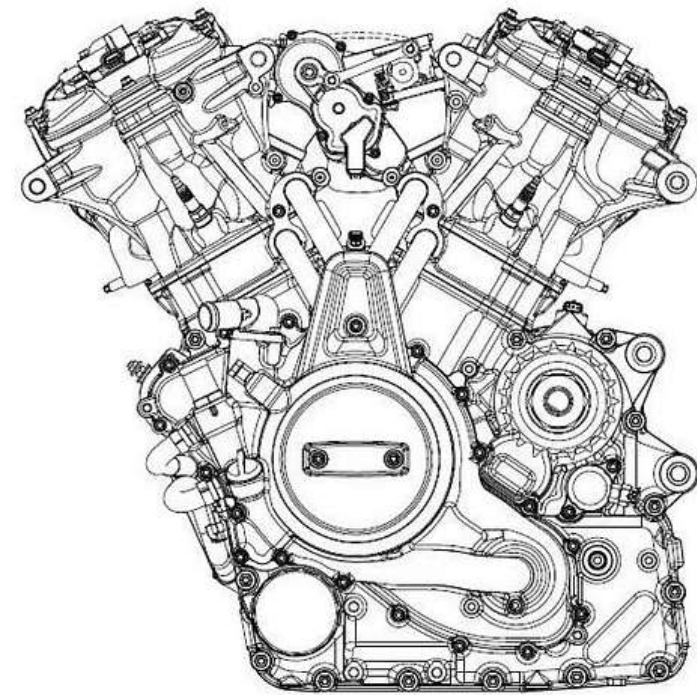
- A **Boxer** type engine (also known as flat twin engine) typically has horizontally opposed pistons. The cylinders are present on two banks on the opposite sides connected to a common crankshaft. The key benefit of the 'Boxer' engine's horizontally opposed layout is not generally about its power output or performance. But its contribution to the handling and stability of the motorcycle, since the weight is evenly distributed on the either sides



HONDA GL1000

- 4 Cylinder Flat engine (Boxer)





Side

Front

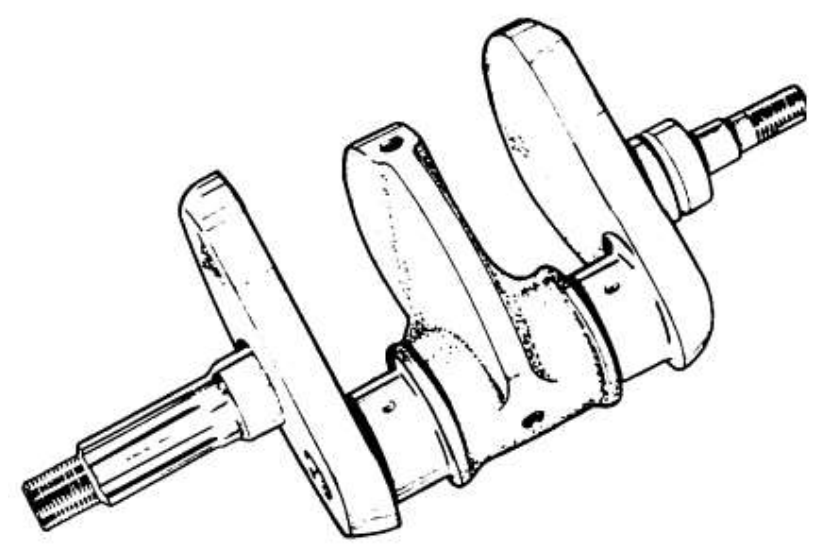
**60° Harley Twin
(one-rod journal)**

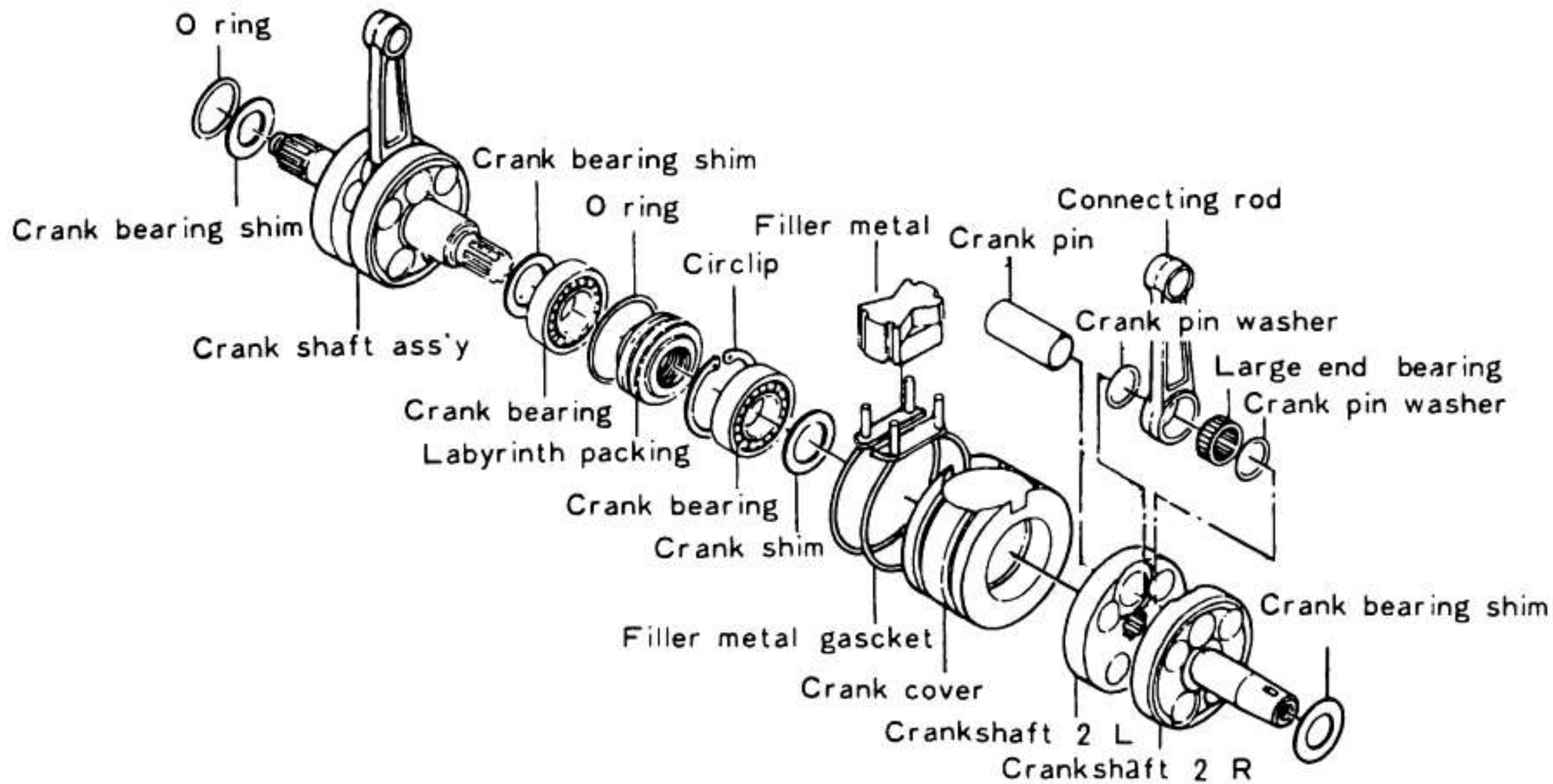
The 60-degree V twin Harley-Davidson

- **60 degrees V-Twin: 2001–
2017 Harley-Davidson VRSC**



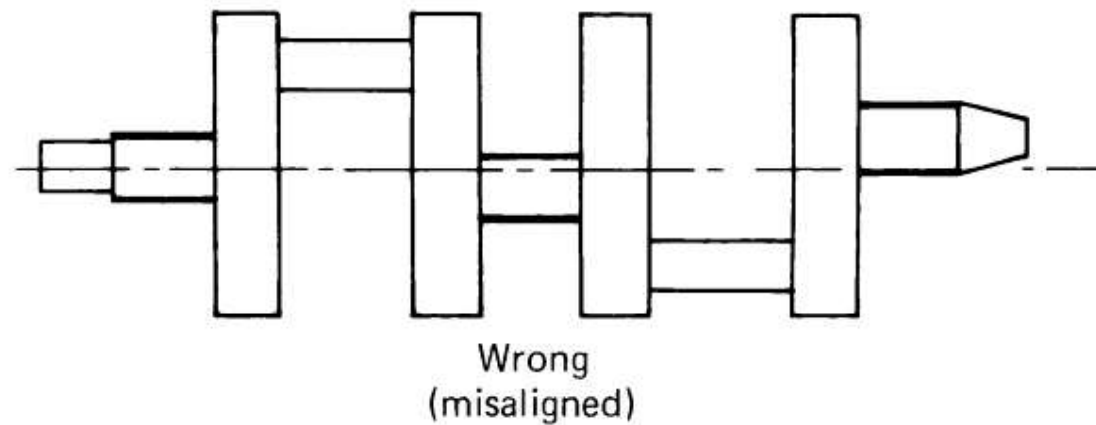
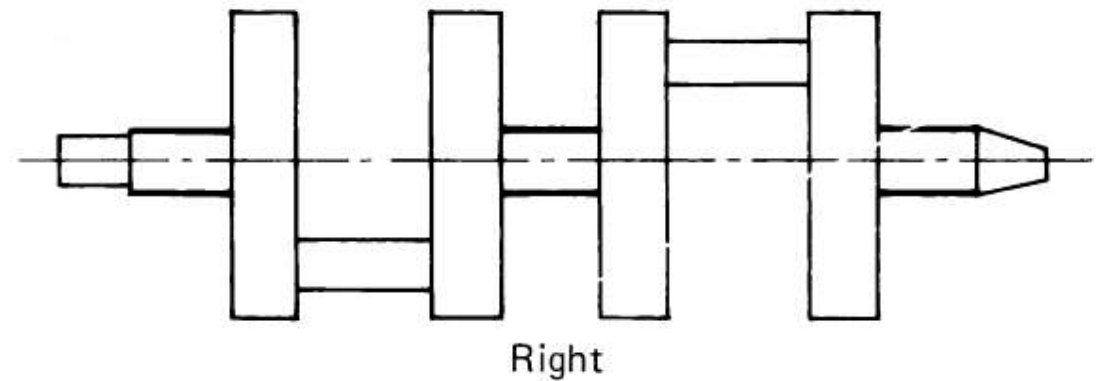
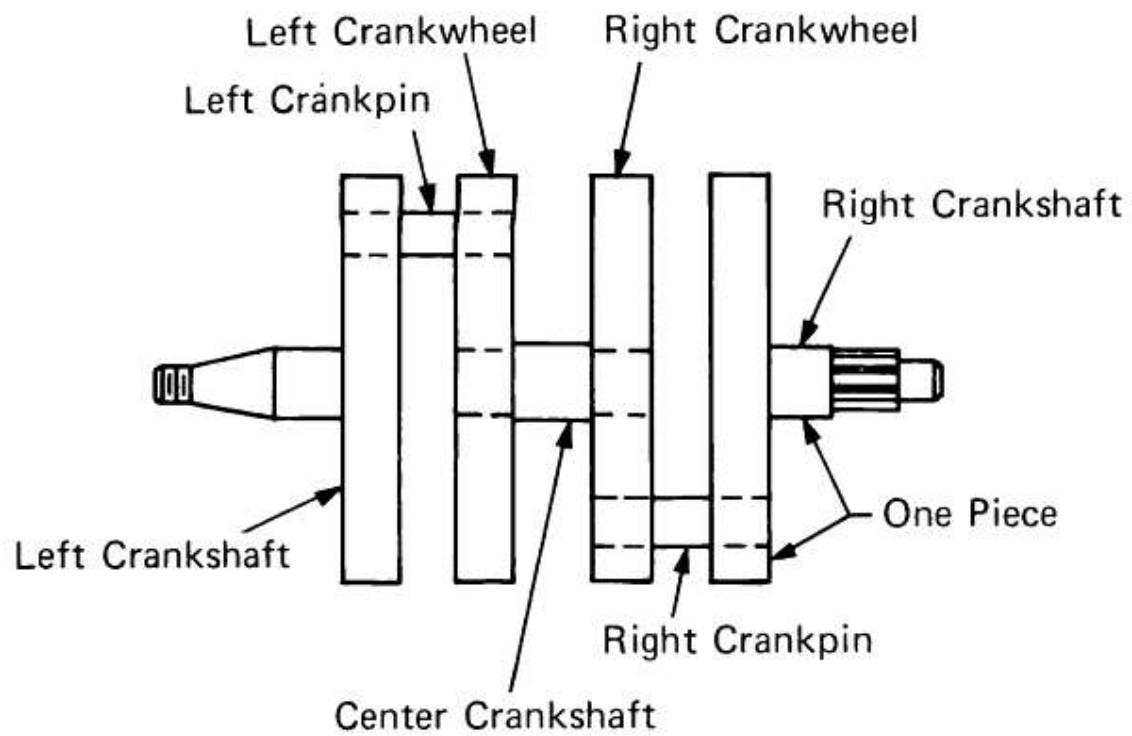
- A **crankshaft** is a mechanical component used in a piston engine to convert the reciprocating motion into rotational motion. The crankshaft is a rotating shaft containing one or more crankpins, that are driven by the pistons via the connecting rods





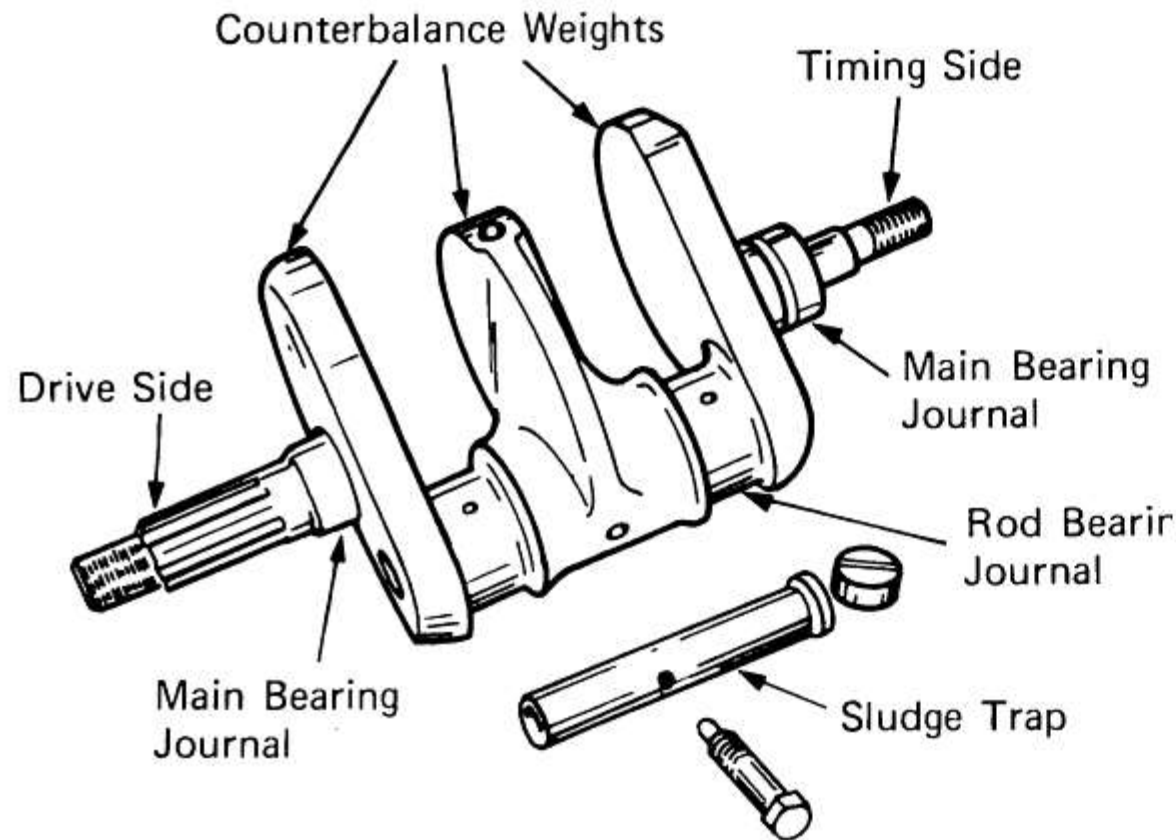
- A **flywheel** is a machinery piece located at one end of a crankshaft. Flywheel not only rotates the engine, the function of the flywheel is to store mechanical energy to balance the engine so that it continues to have good performance. Mechanical power is the energy created when the engine is running. The flywheel works to balance the mechanical power by storing it.



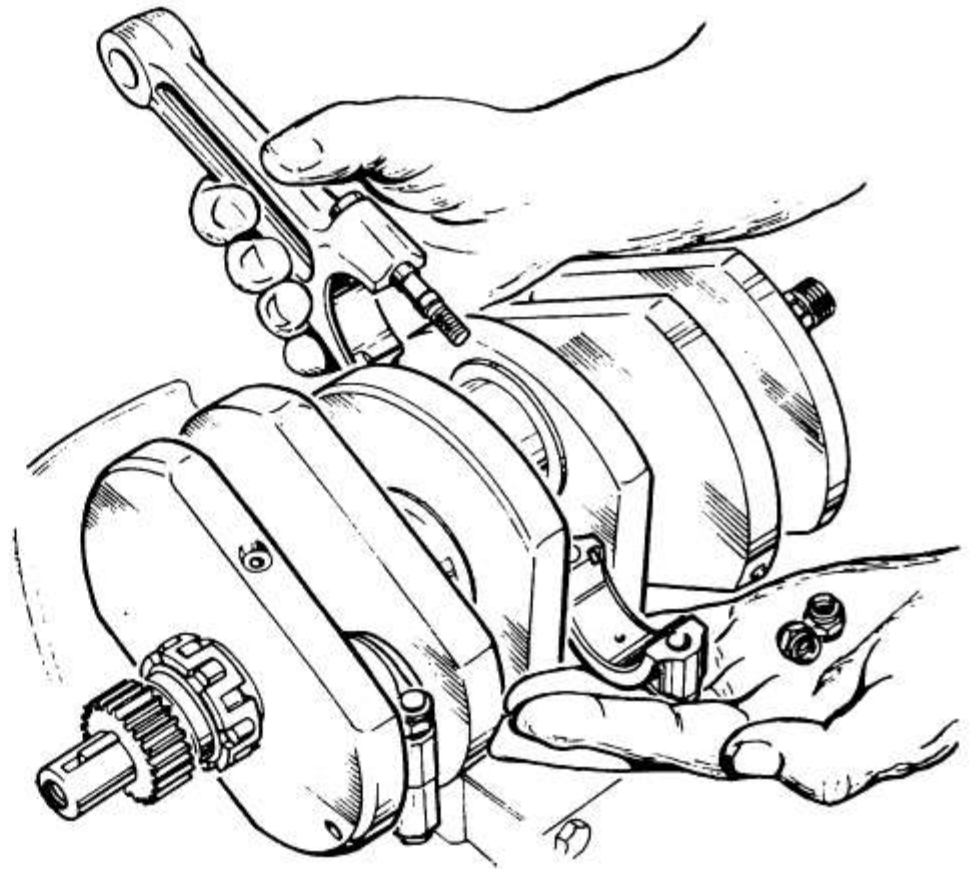


CRANKSHAFT ALIGNMENT

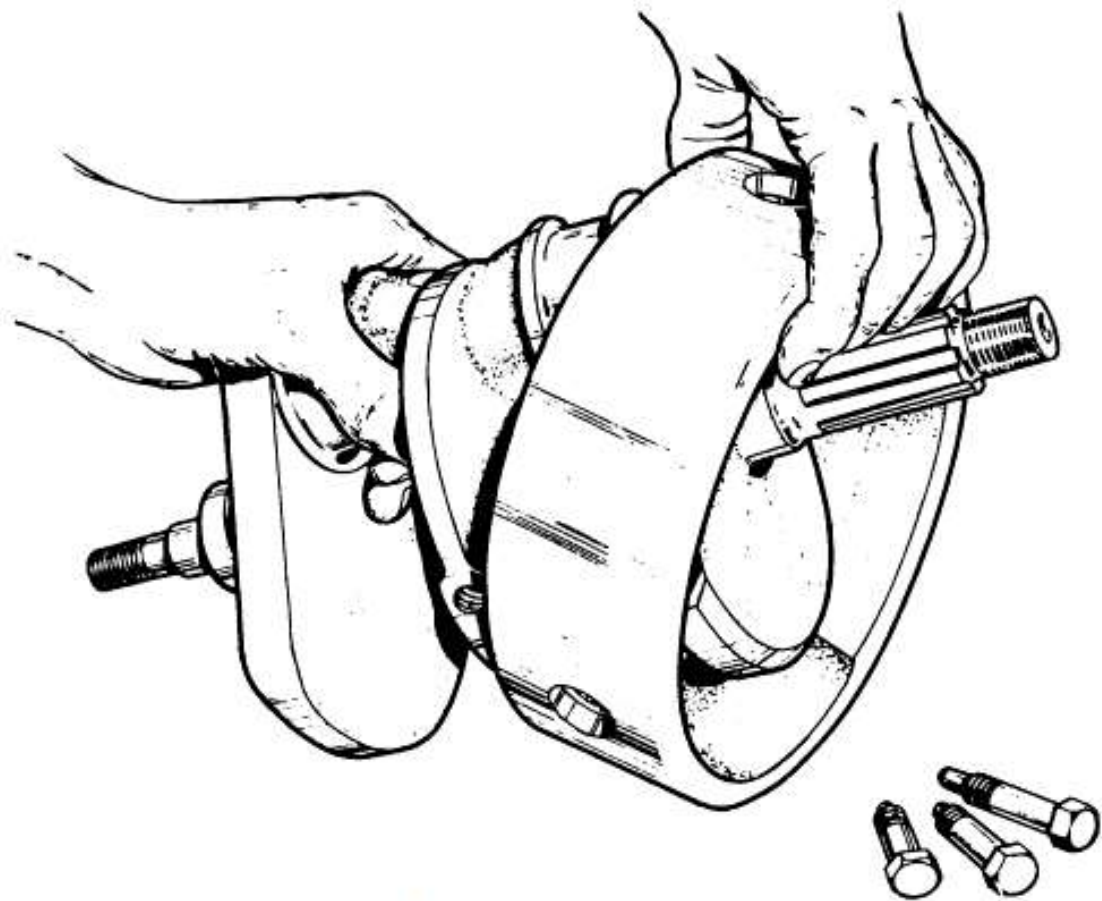
- **Outside Ends of the crankshaft**
- **One-piece crankshaft:** Most one-piece cranks use a single metal forging as left crank, right crank and bottom bracket axle



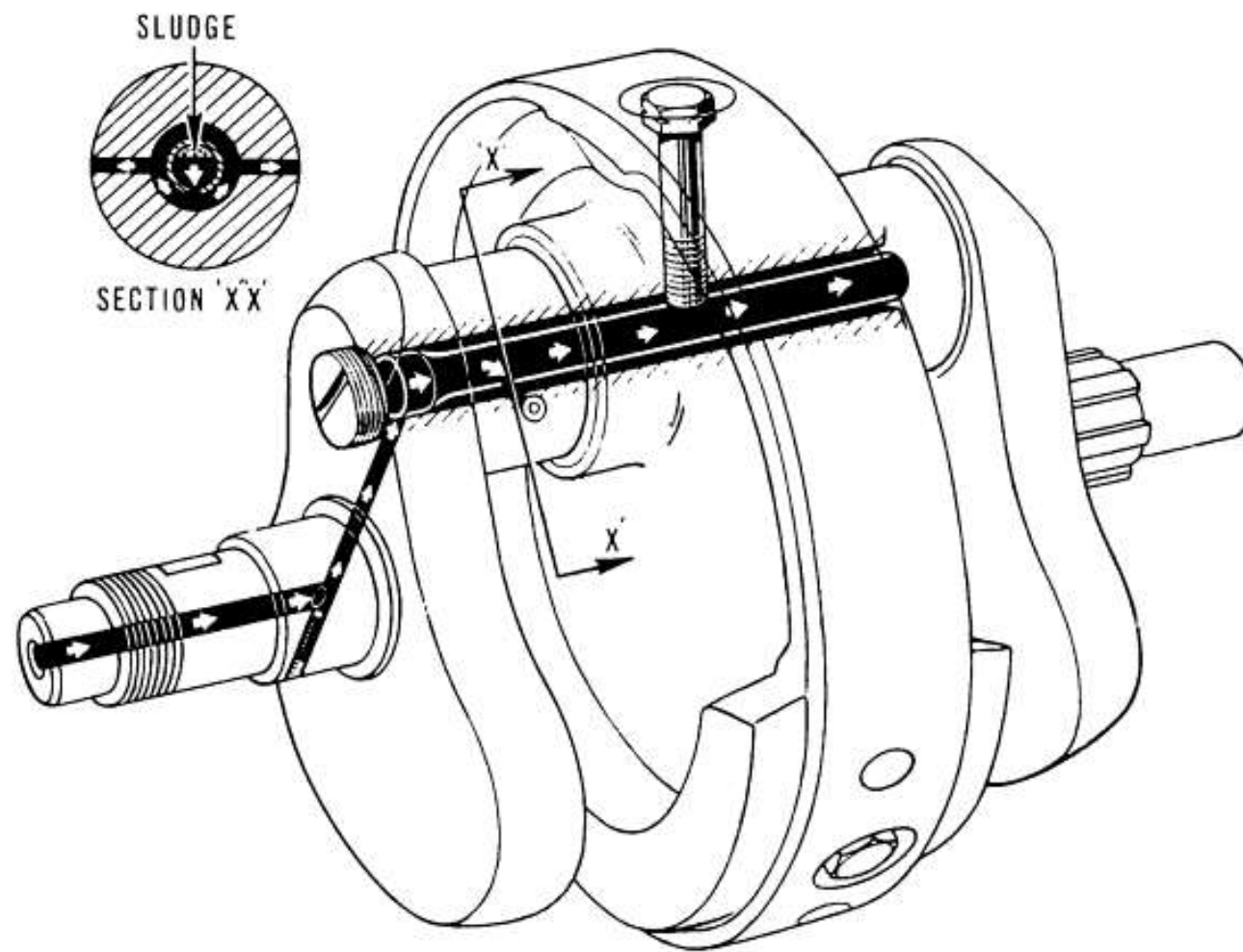
Crankshaft parts and position



Split Connection rods on solid crankshaft



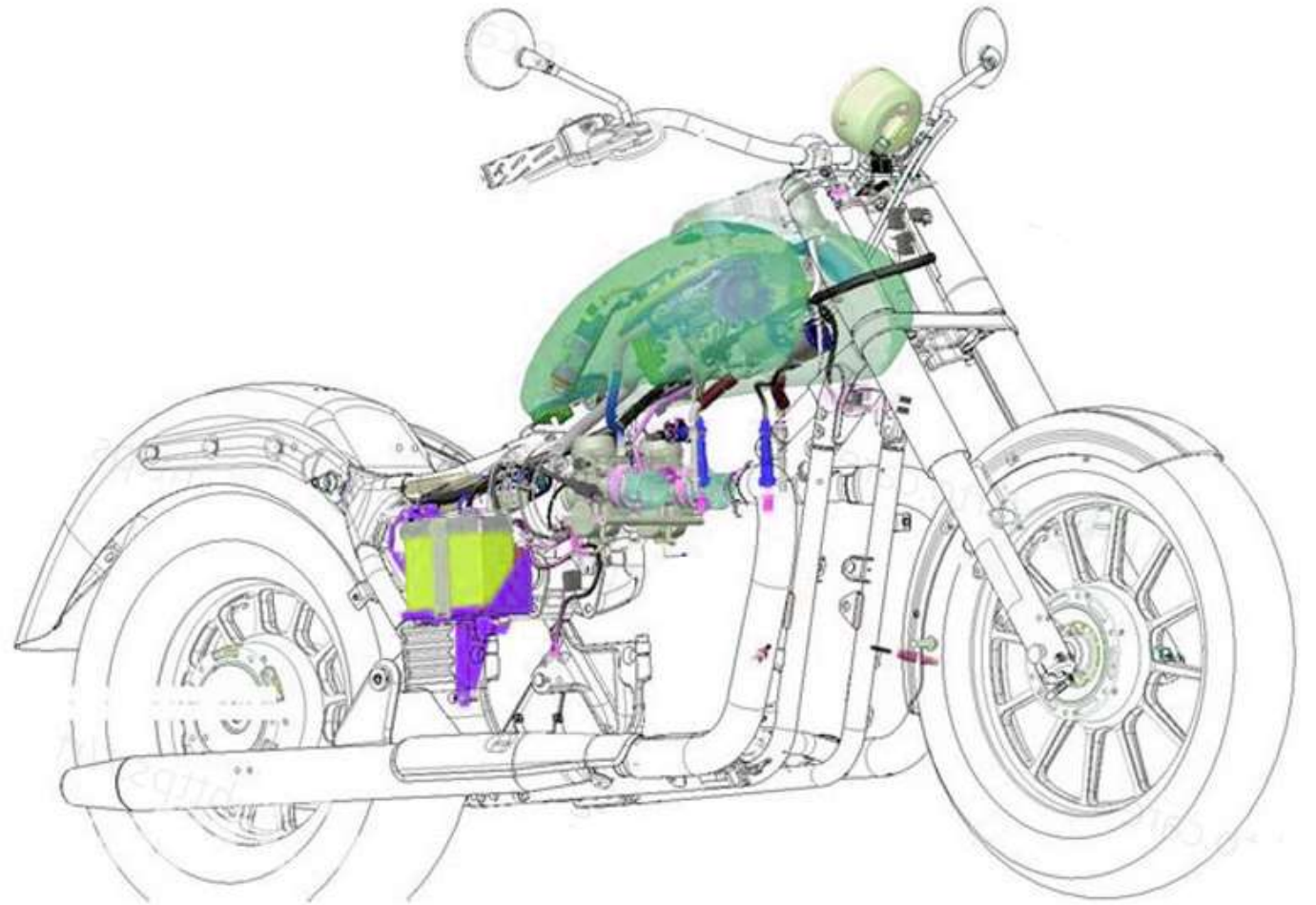
Flywheel removal



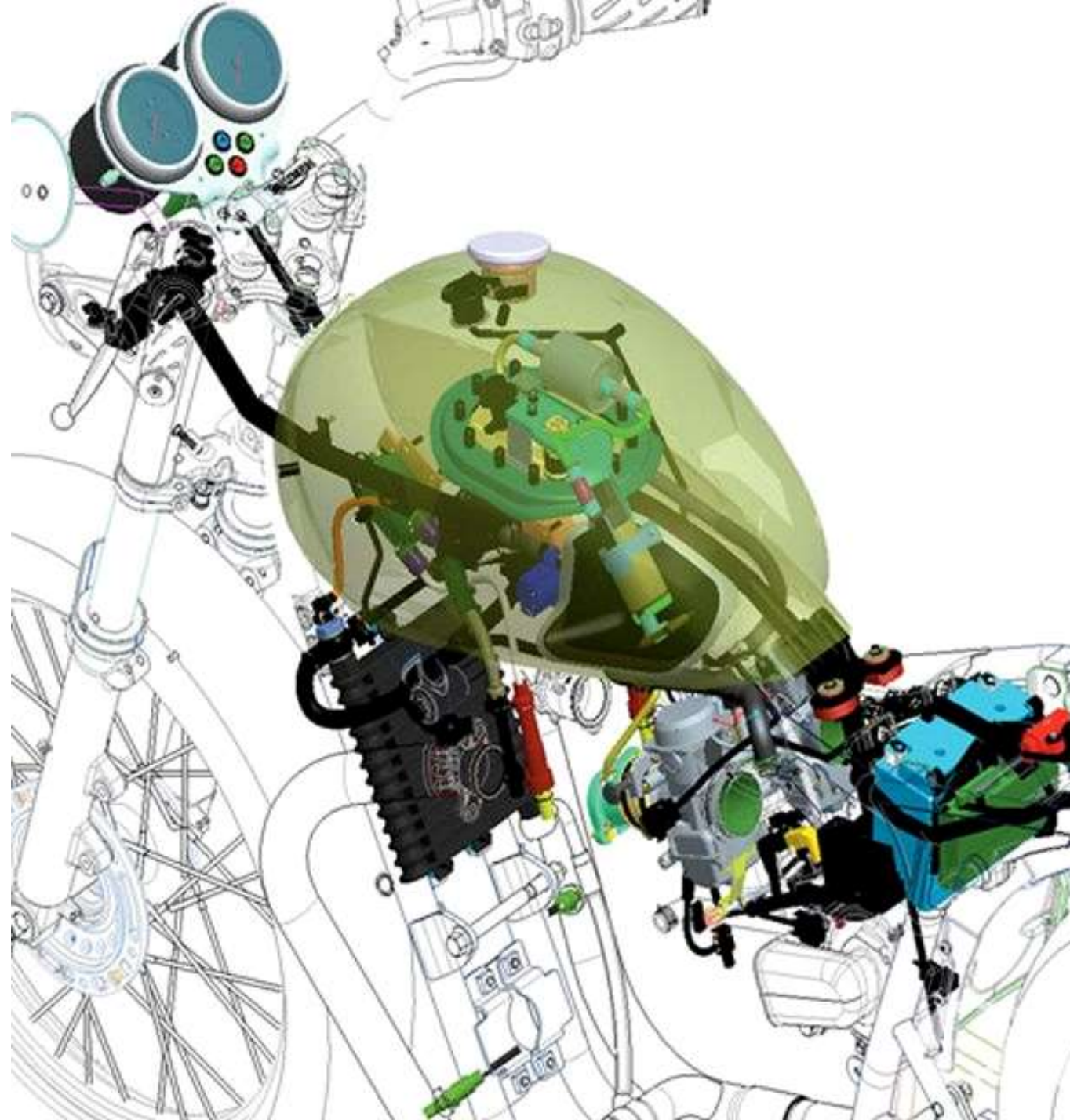
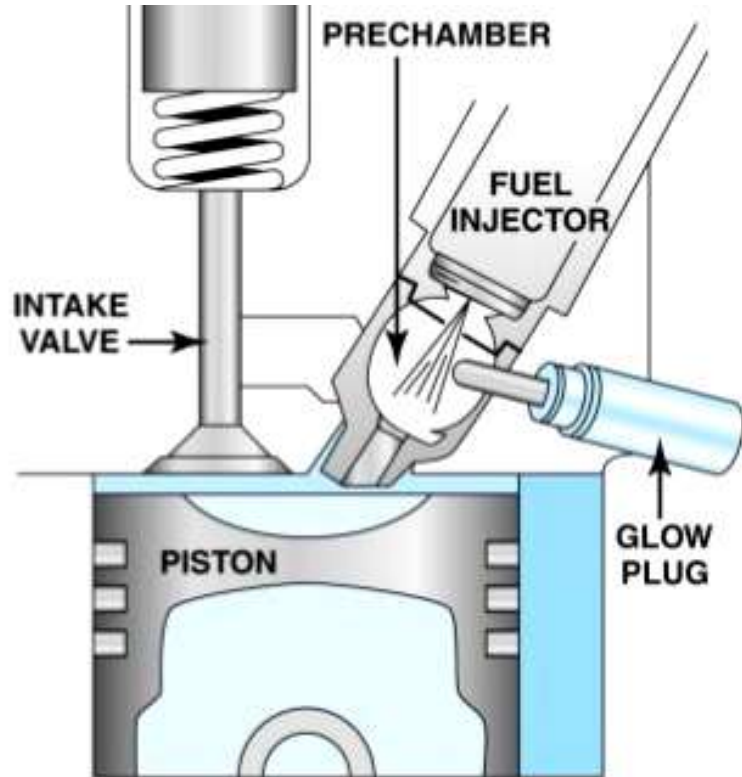
Crankshaft Sludge trap

Fuel Systems

- A **carburetor** is a device used by a gasoline internal combustion engine to control and mix air and fuel entering the engine. The primary method of adding fuel to the intake air is through the Venturi tube in the main metering circuit, though various other components are also used to provide extra fuel or air in specific circumstances.

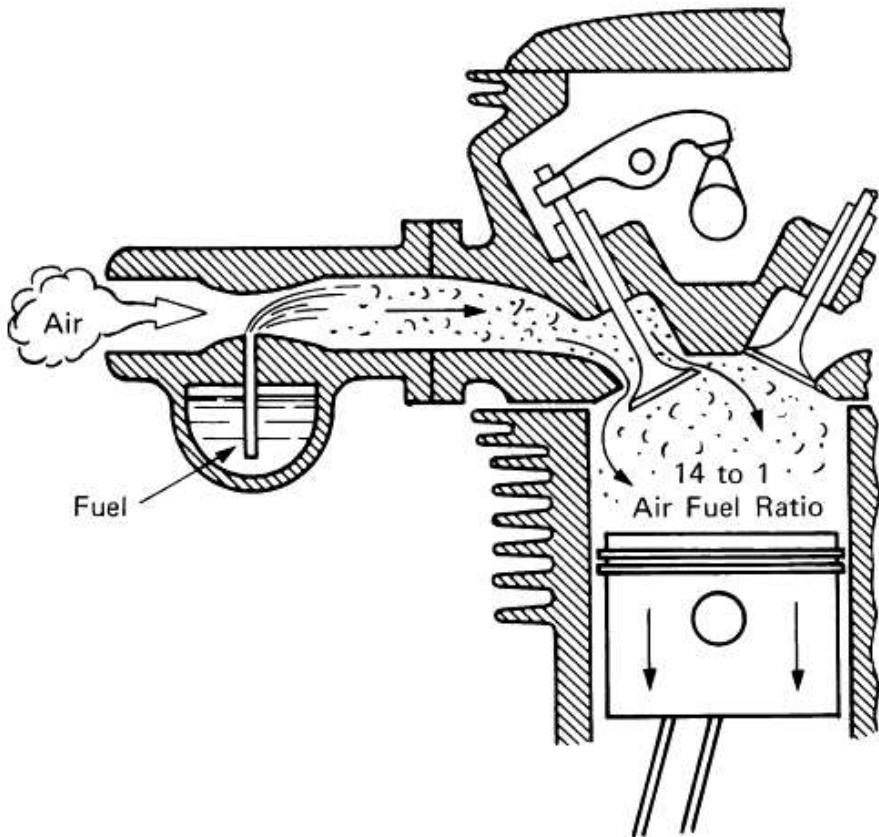


- Motorcycle fuel injection system

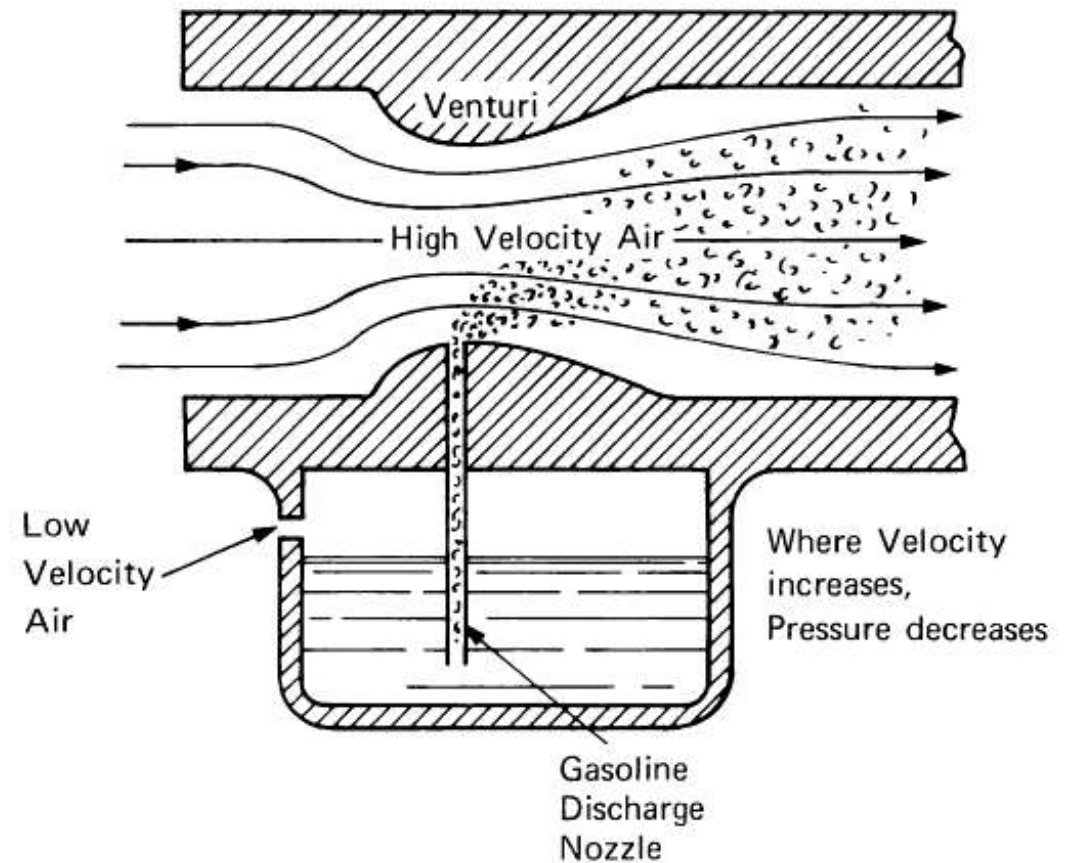


There are two types of carburetors:

- **Fixed venturi:** The velocity of the airflow is used to regulate the flow of the fuel.
- **Variable venturi:** The flow of raw fuel is controlled mechanically, and airflow is regulated with fuel flow



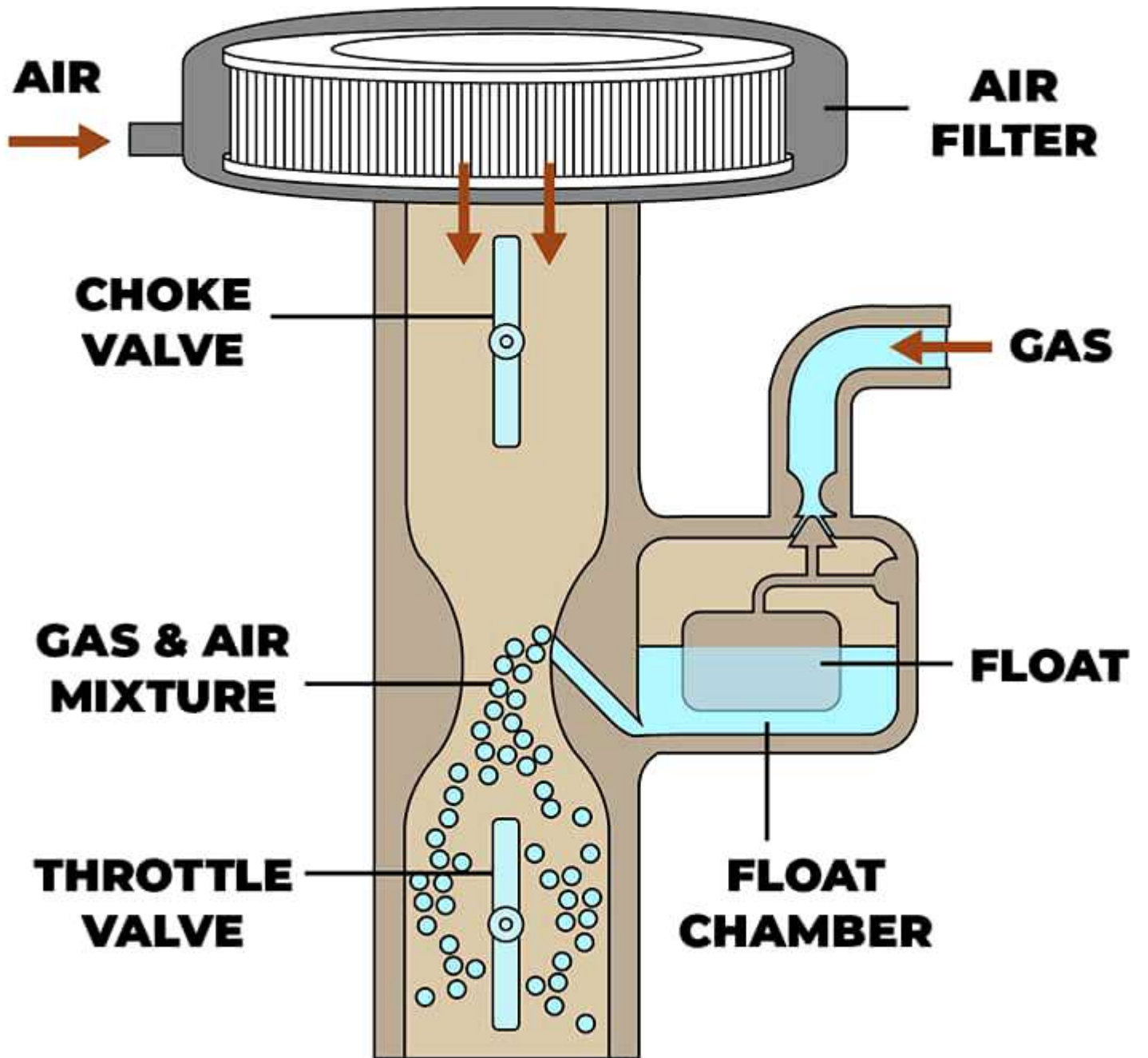
Carburetor supplies fresh fuel air mixture



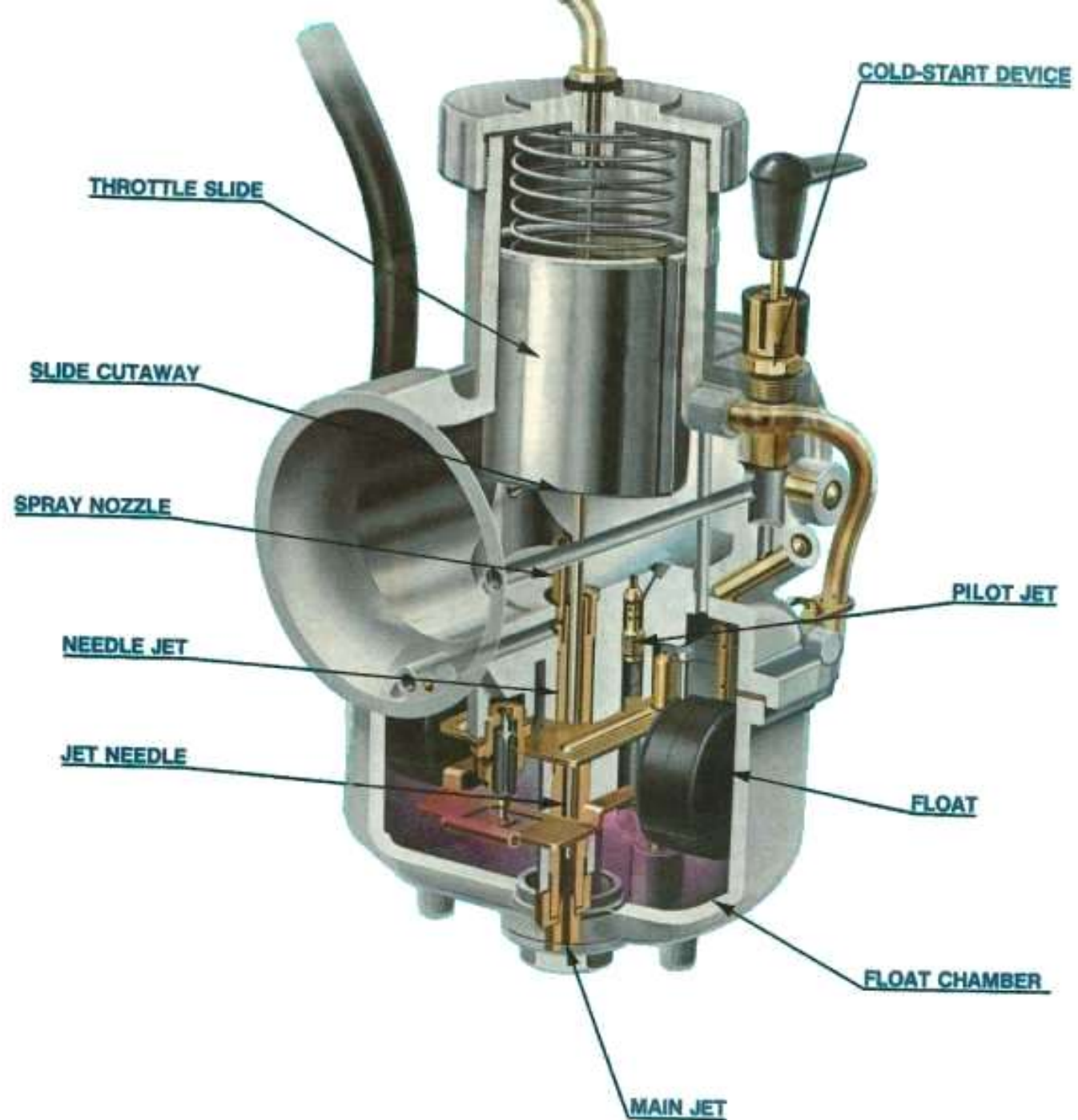
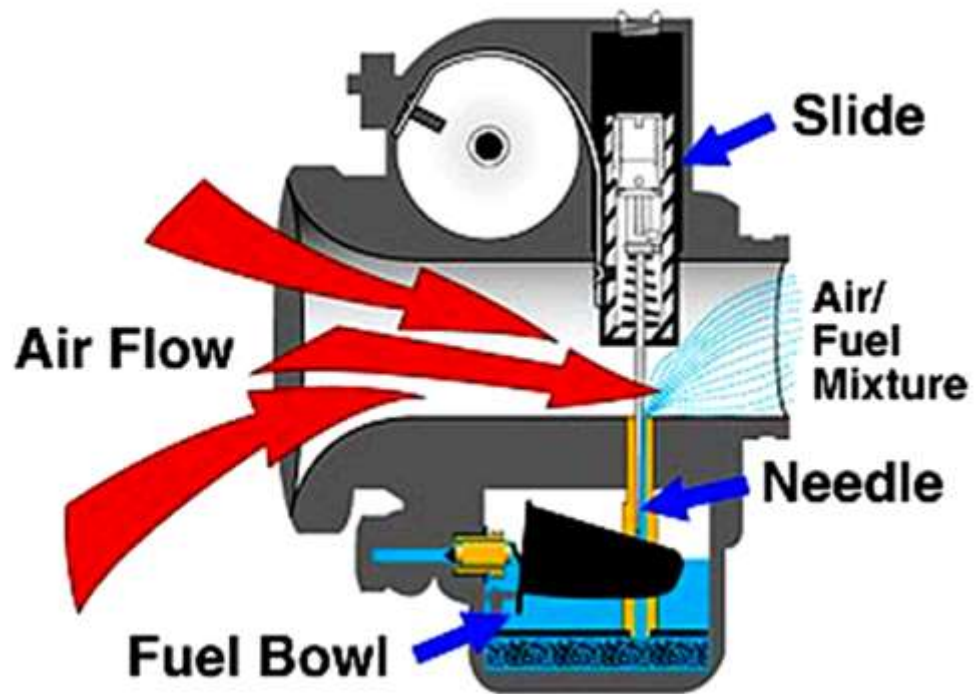
Fuel flows to low pressure area

Operation Principle

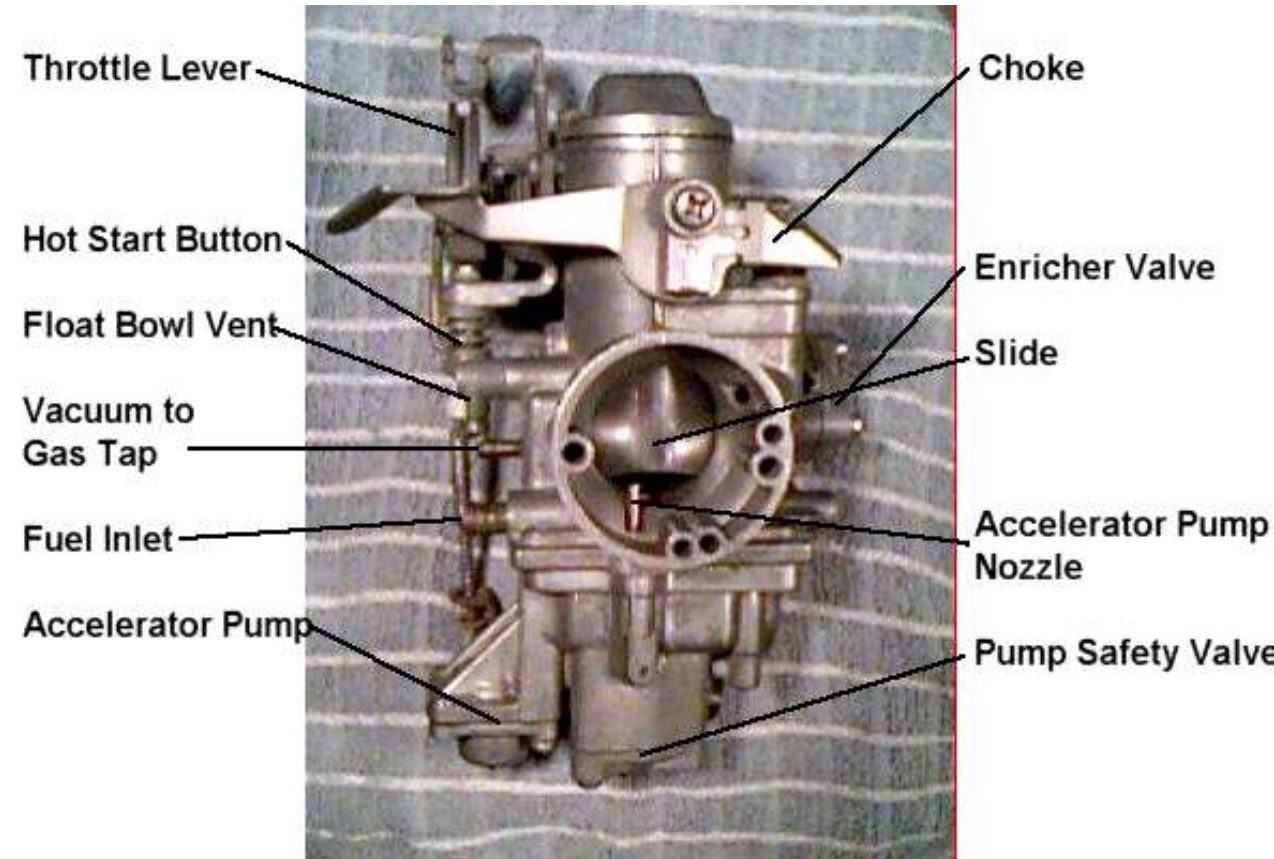
- Air from the atmosphere enters the carburetor (usually via an air cleaner), has fuel added within the carburetor, passes into the inlet manifold, then through the inlet valve(s), and finally into the combustion chamber. Most engines use a single carburetor shared between all of the cylinders, though some high-performance engines historically had multiple carburetors.



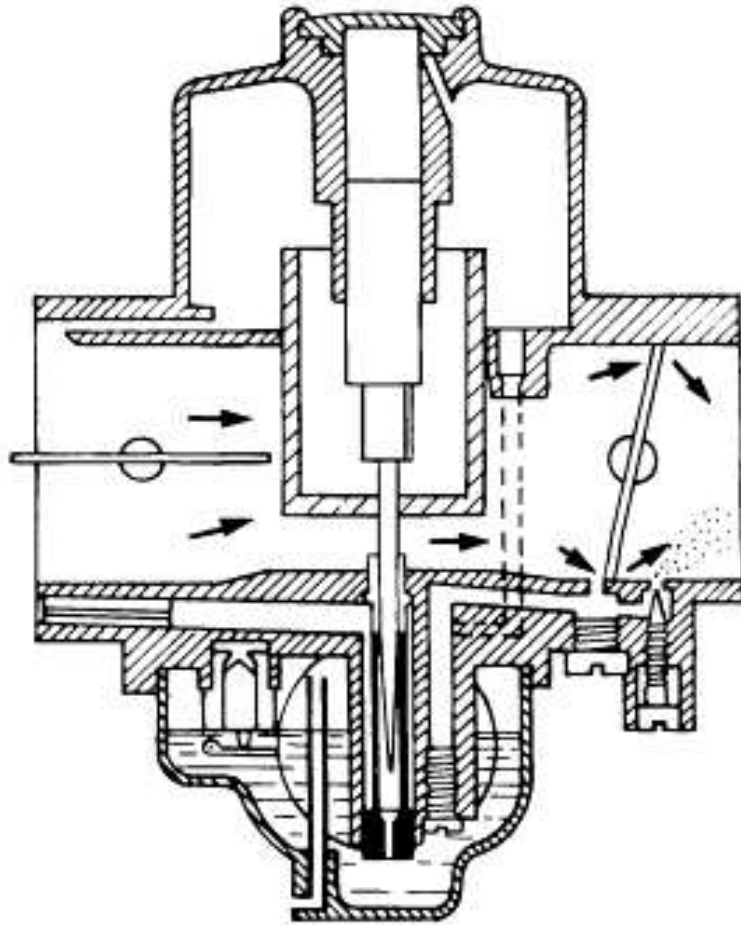
- **Slide Carburetor** On a slide carburetor the throttle cable is directly attached to a slide valve that lifts the jet needle to regulate fuel flow depending on the position of the slide



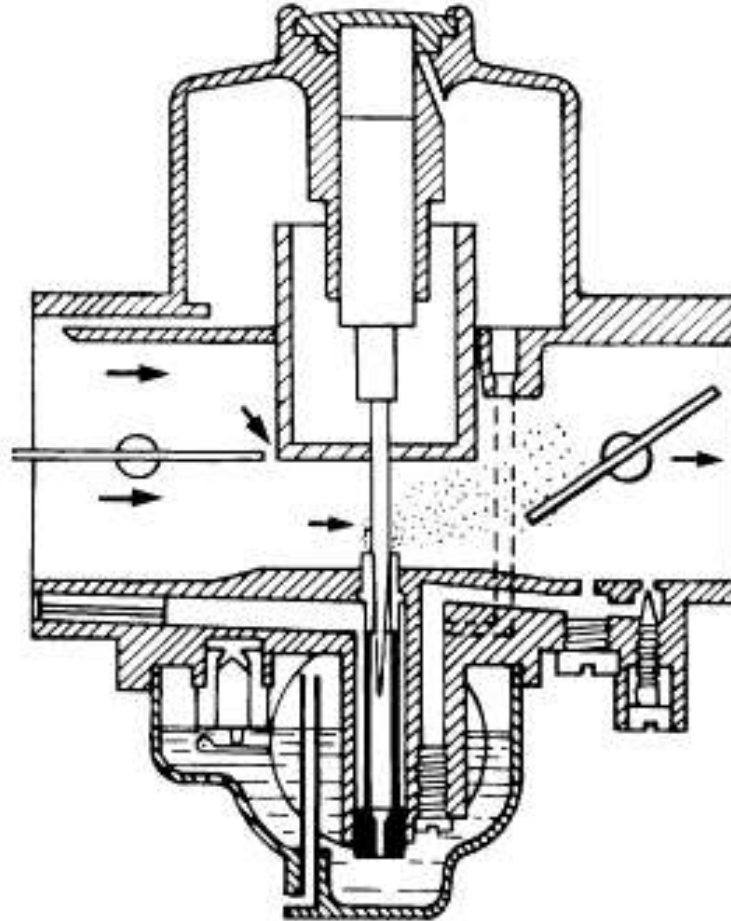
- The main difference between a constant velocity (CV) carburetor and a slide carb is the way in which they control the flow of air and fuel into the engine.
- In a slide carb (like the ones found on most dirt bikes), the throttle cable is directly connected to a slide valve. As the throttle cable is moved, the slide is lifted to allow more air and fuel to flow into the engine. The amount of fuel is controlled by the position of the needle jet and the size of the main jet



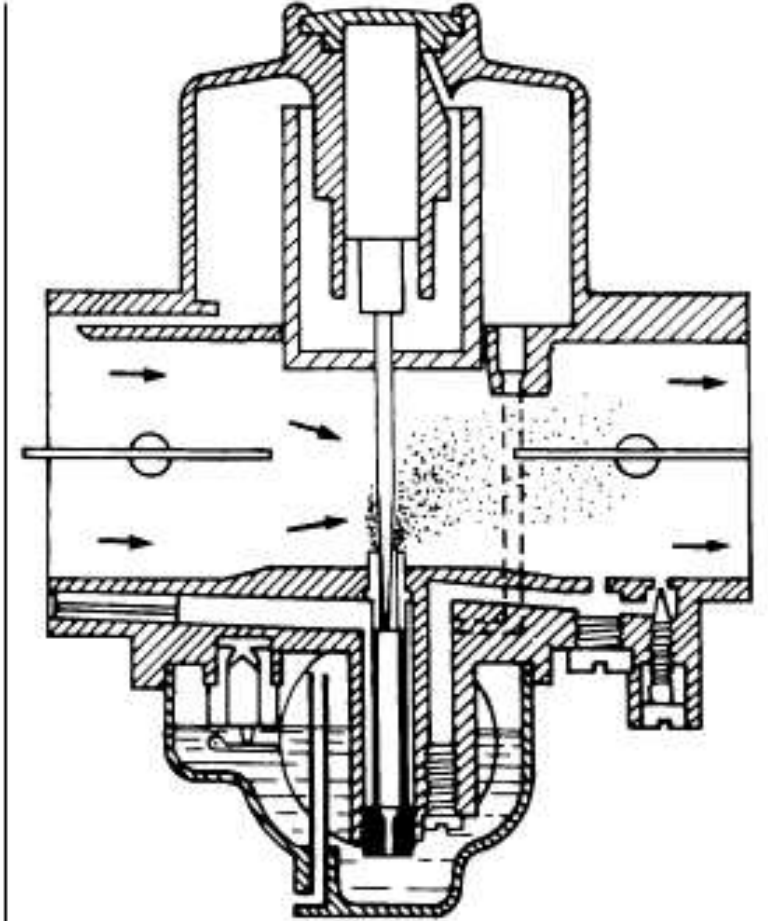
- **A constant velocity (CV) carburetor** uses vacuum to lift the jet needle to suck fuel through the main jet



(a) IDLE



(b) MID-RANGE

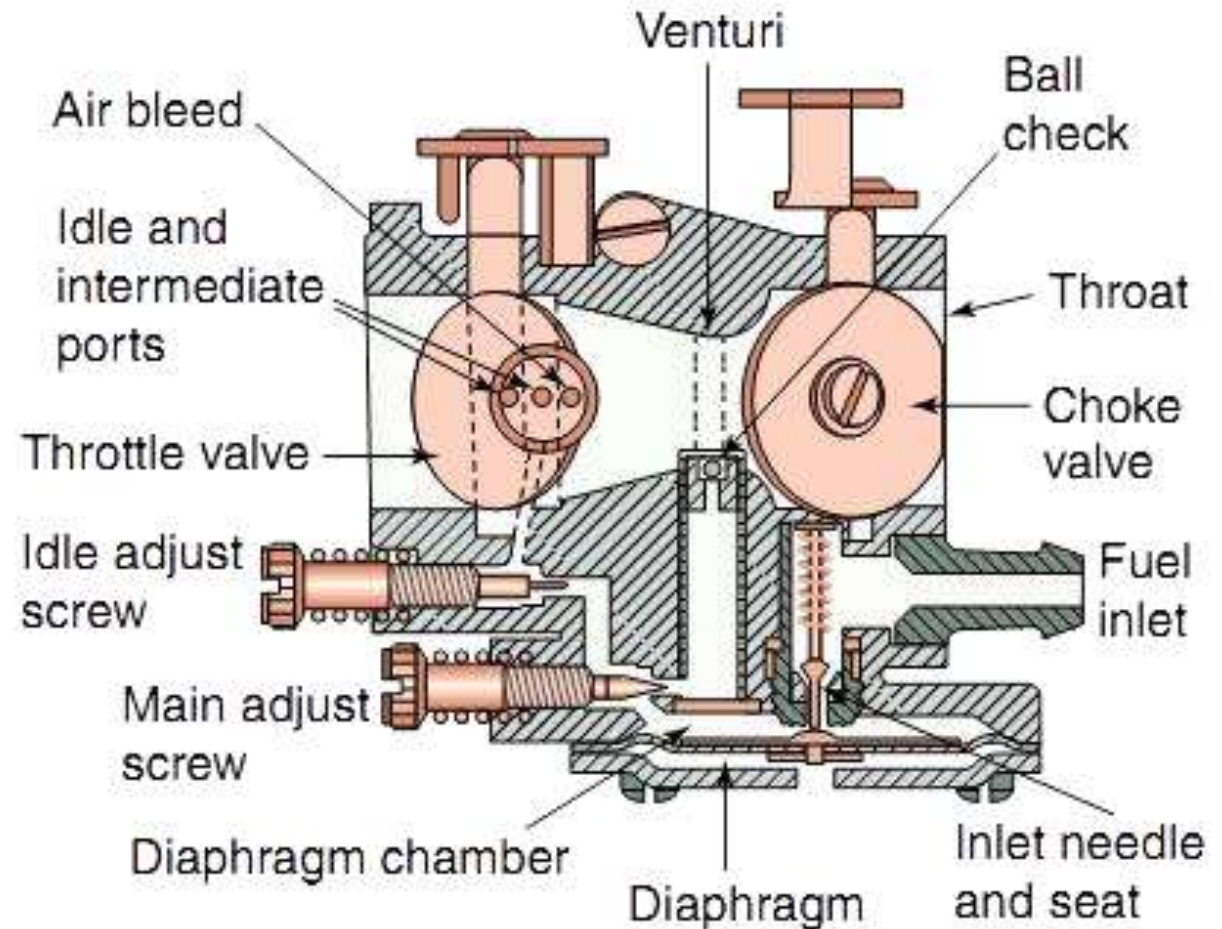
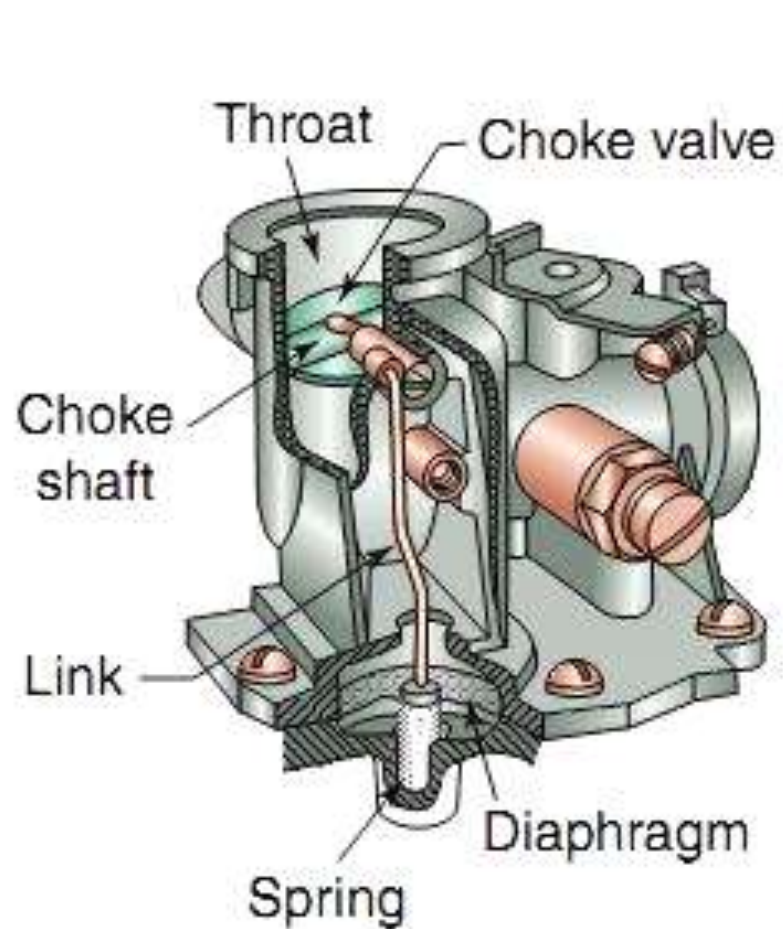


(c) HIGH SPEED

- In contrast, a CV carb works by using a vacuum signal to maintain a constant air velocity through the carburetor. This means that the CV carburetor automatically adjusts the amount of air and fuel entering the engine, according to the engine's demand, without the need for a separate slide valve. As the throttle is opened, the vacuum created by the engine is increased and the CV carburetor automatically compensates by allowing more air and fuel to flow into the engine. This results in smoother and more responsive acceleration than a slide carburetor. Additionally, the CV carburetor is more fuel-efficient than a slide carburetor

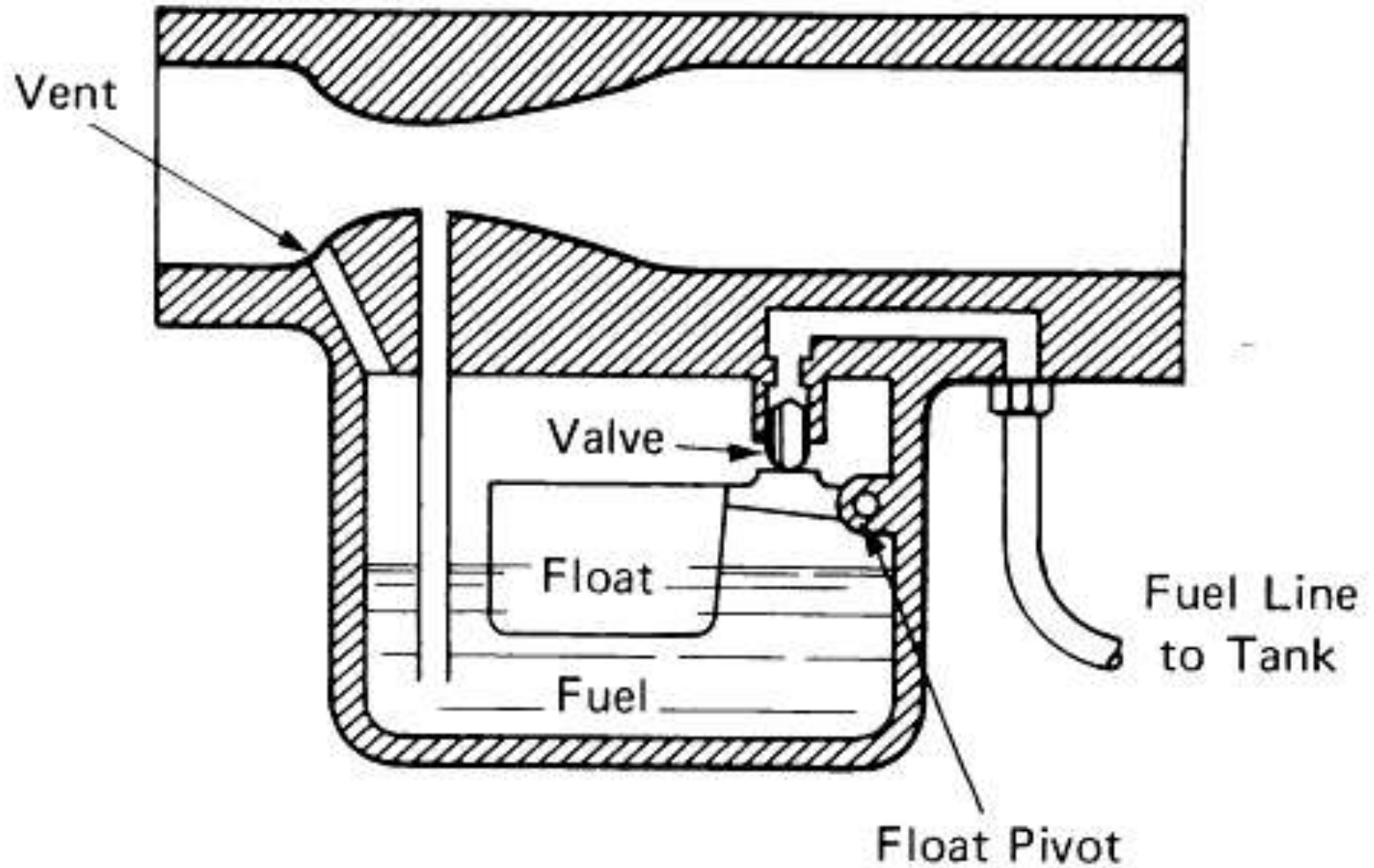


CARBURETOR CIRCUITS

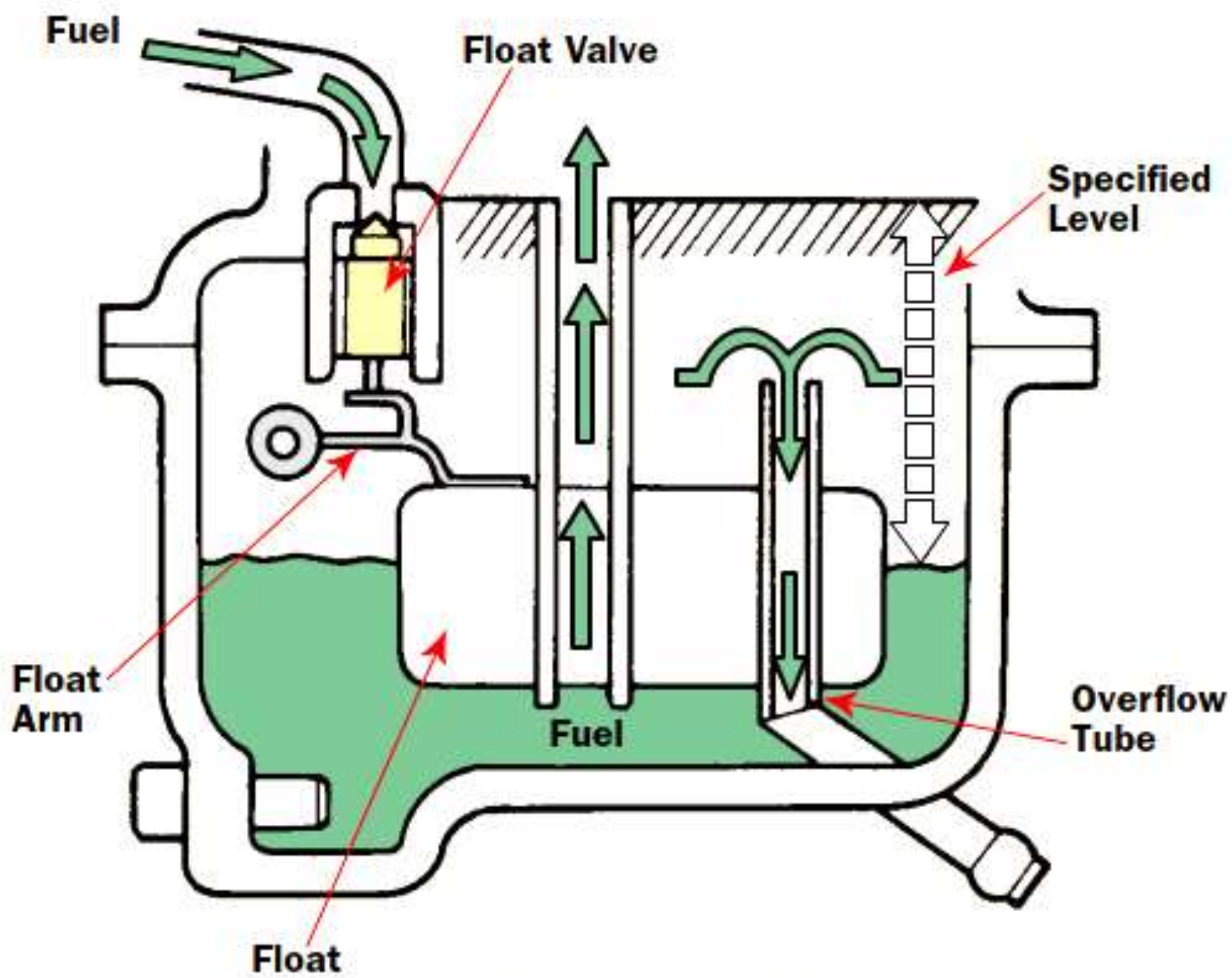


Float Circuit

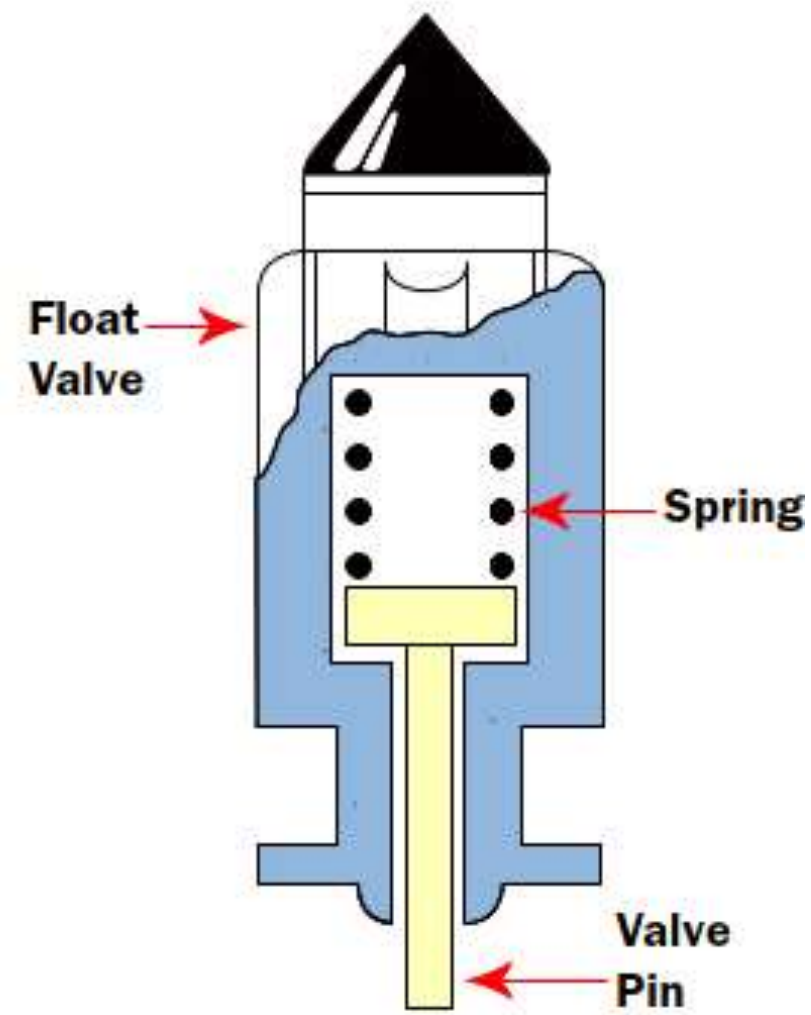
- The float circuit's job is to ensure that all of the other circuits have the fuel they need



Carburetor float system

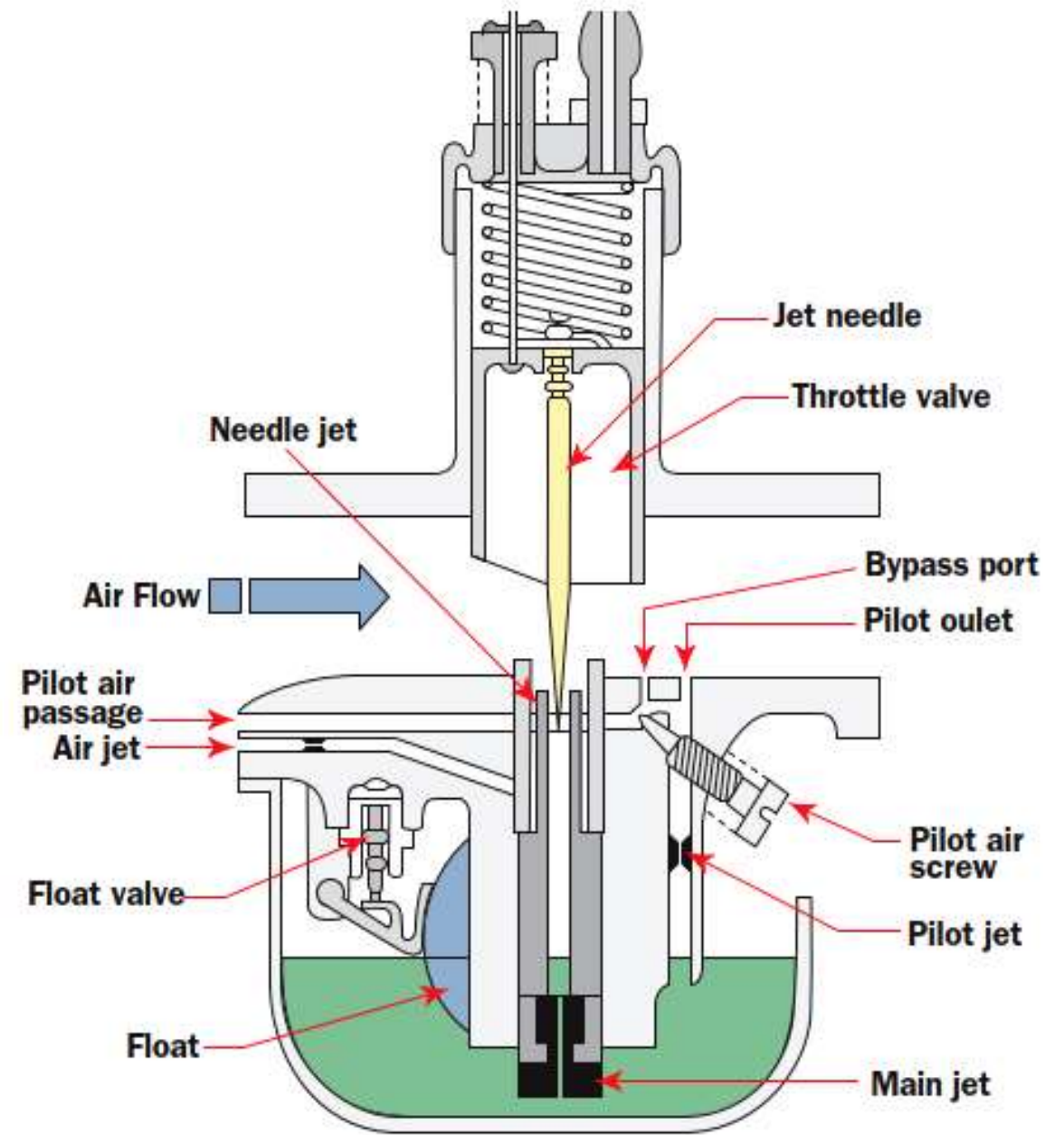


Float System

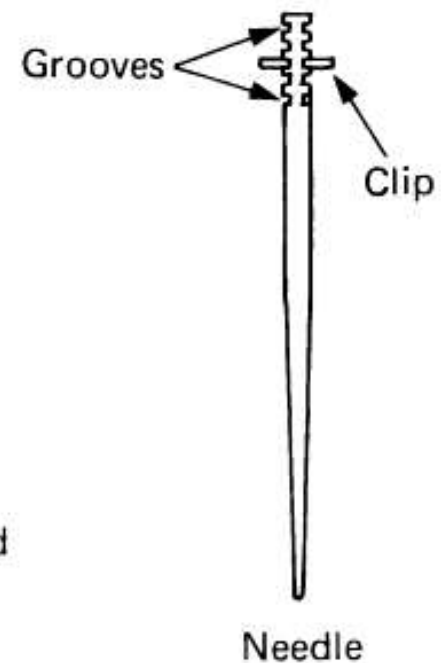
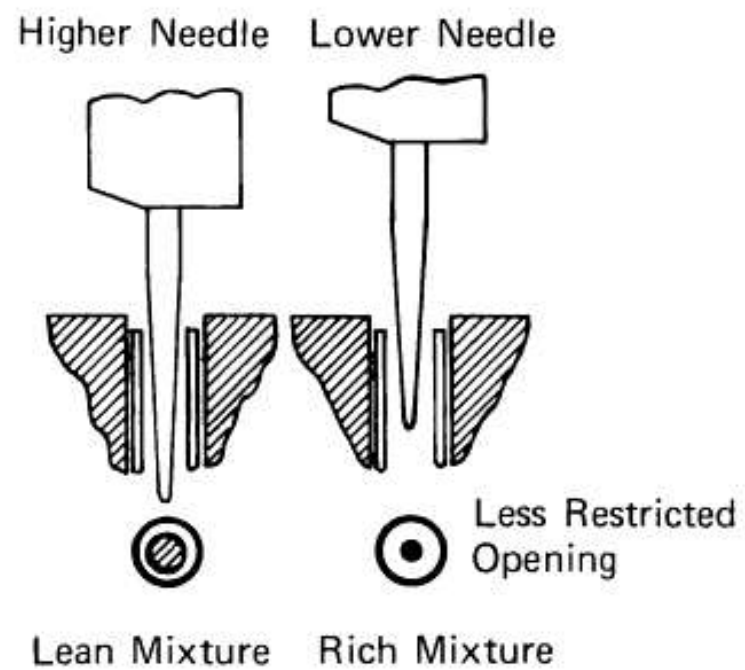
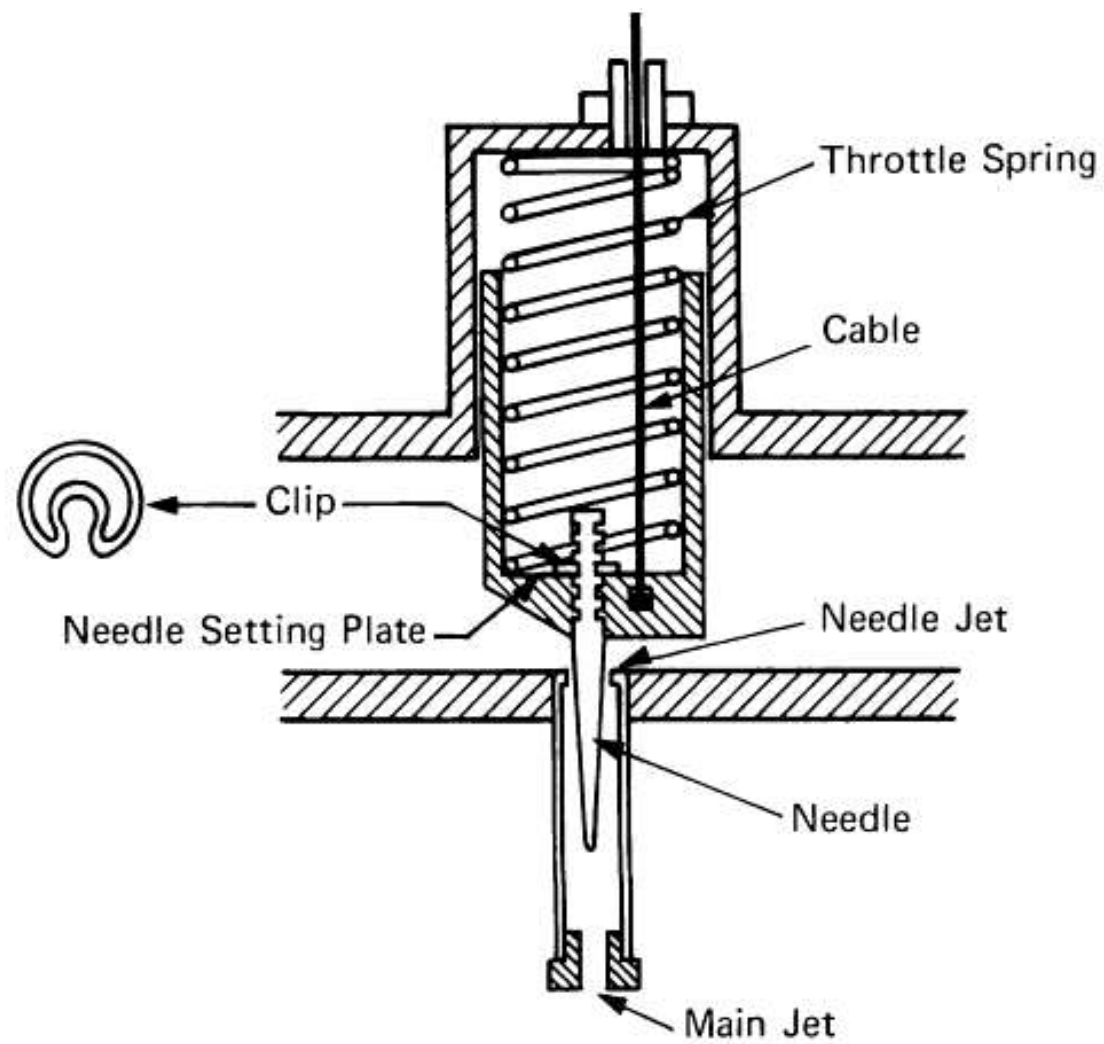


Jets and Jet Needle

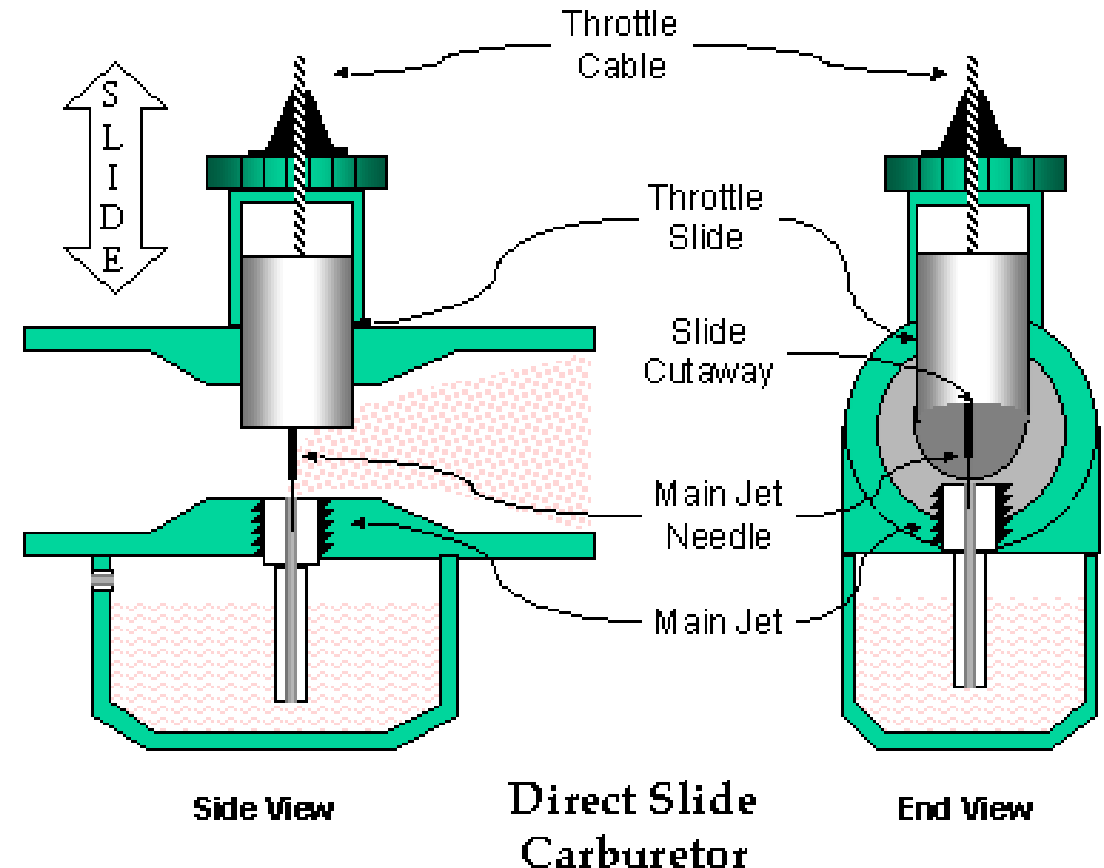
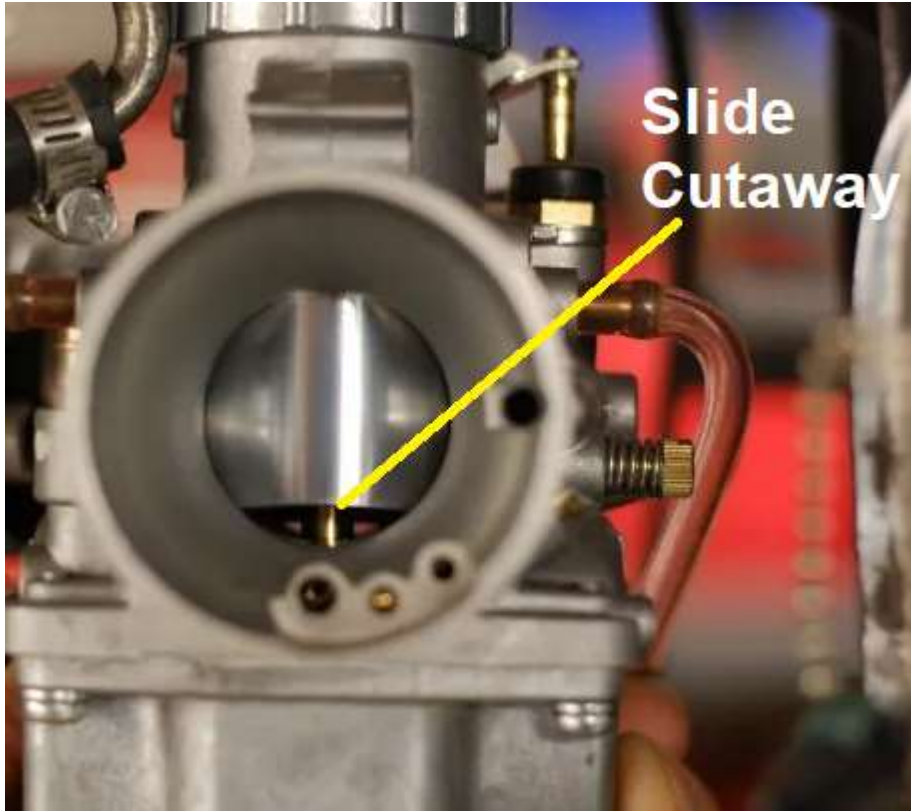
- The pilot jet is a very small jet used to control fuel flow at idle and very low throttle openings.



slide carburetor

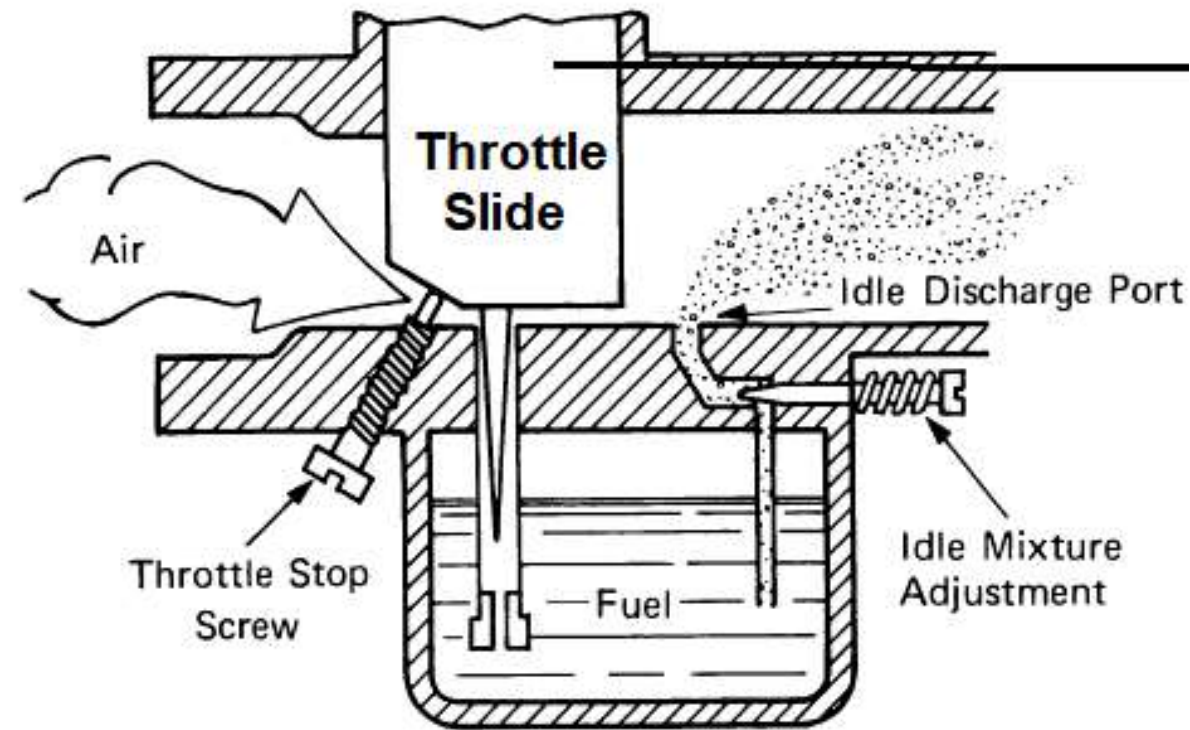


- **Slide Cutaway** The throttle valve will have a “cutaway” on the air box/intake side of the carburetor, and it basically impacts the pressure signal across the pilot and needle jet. So by altering the cutaway size on the throttle valve, the pressure/signal of airflow through the carburetor can be changed. Therefore a smaller cutaway will have a stronger signal due to creating lower pressure, thus a richer condition, than a larger cutaway will.

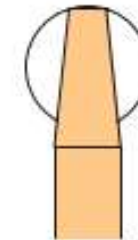
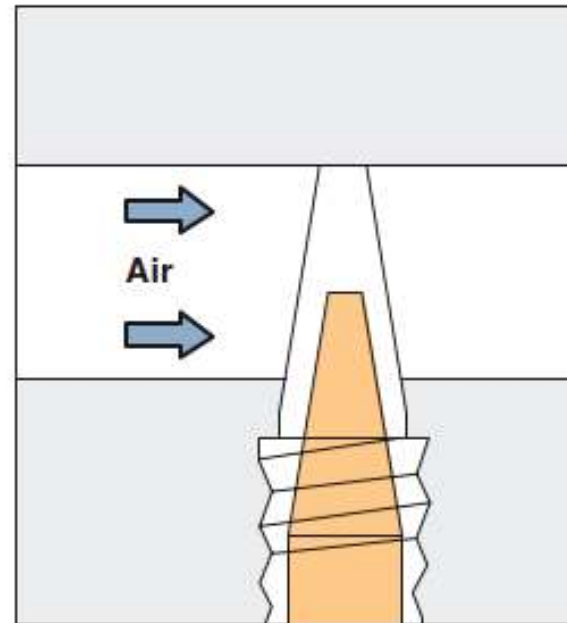


Low-Speed (Idle) or Pilot Circuit

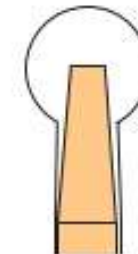
- The **pilot jet** controls the fuel level when you're at idle to roughly 20% throttle



Idle circuit operation

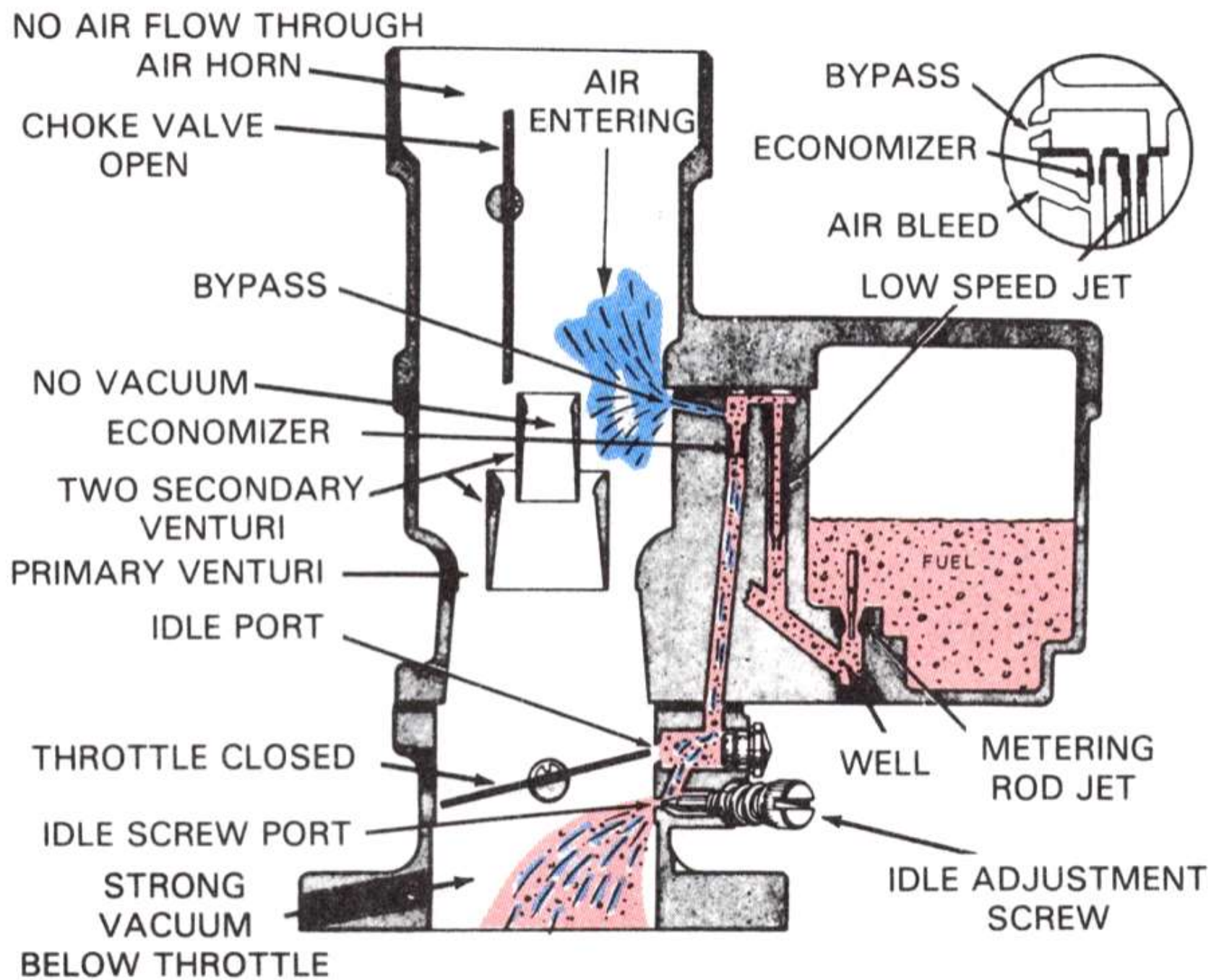


Air screw is tightened.
(Air flow reduced
mixture "rich")



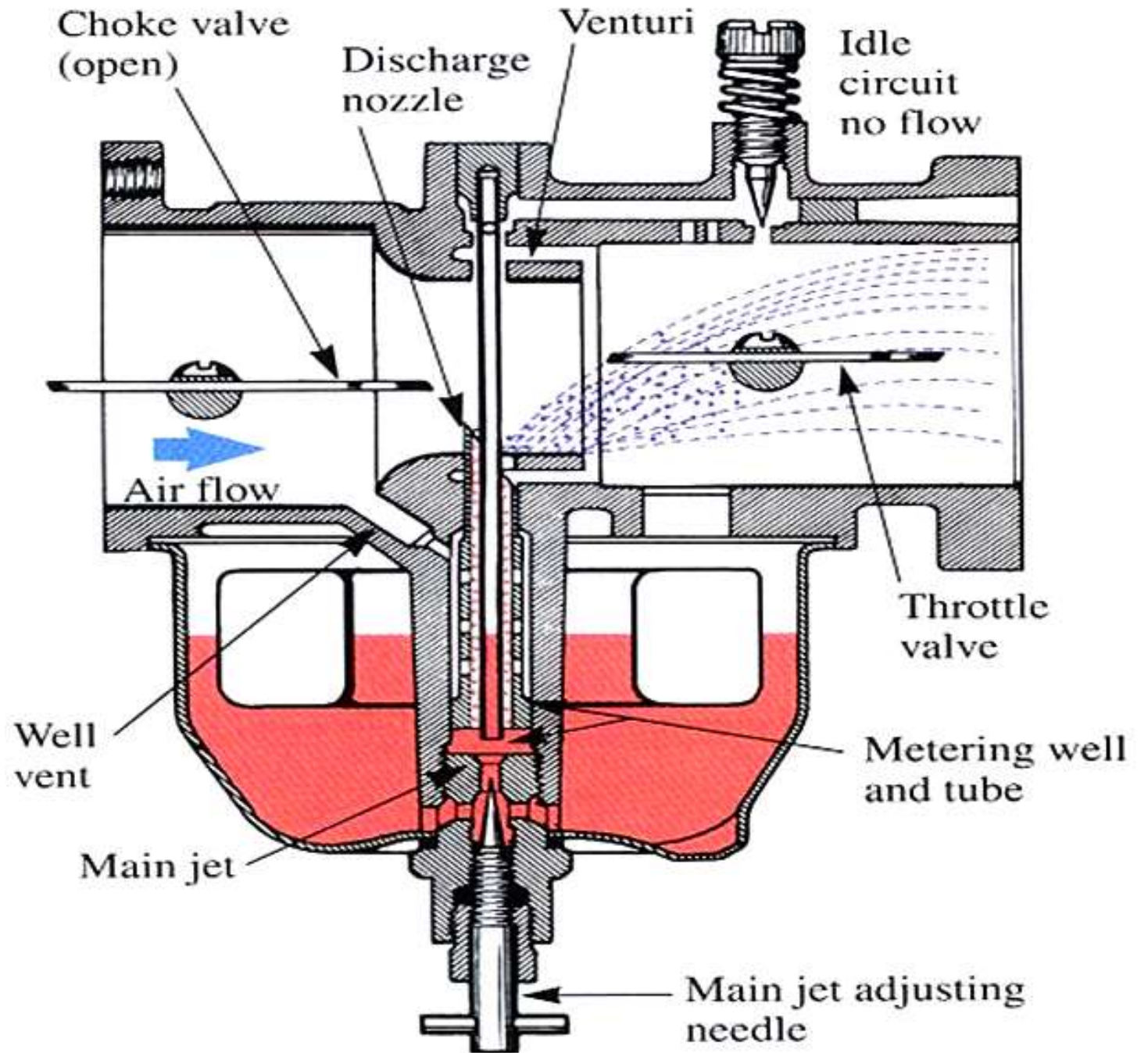
Air screw is loosened.
(Air flow increased
mixture "leaner")

The pilot screw regulates either air or fuel depending on the carburetor. On the VM Mikuni the screw regulates airflow.



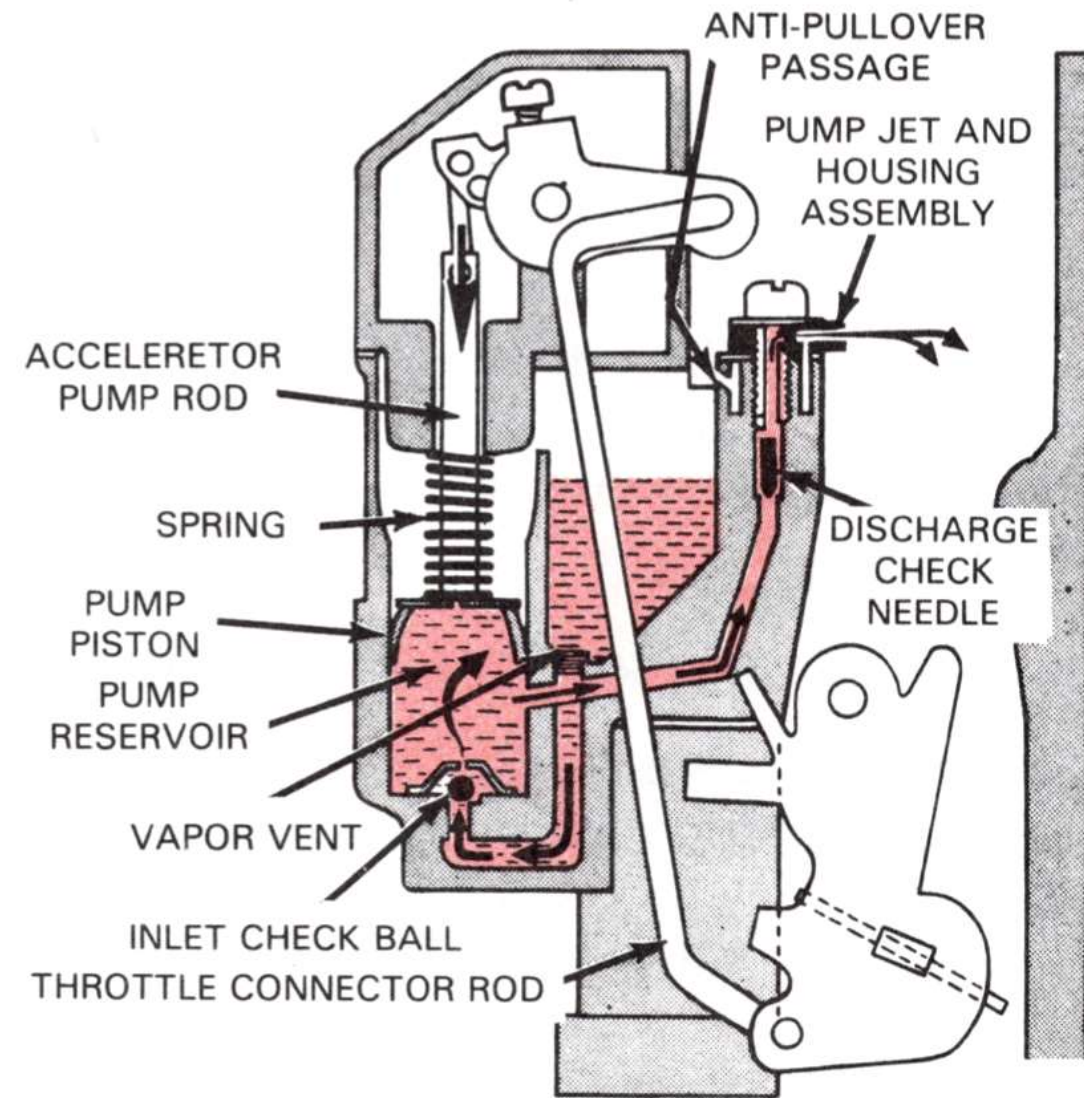
High-Speed Circuit

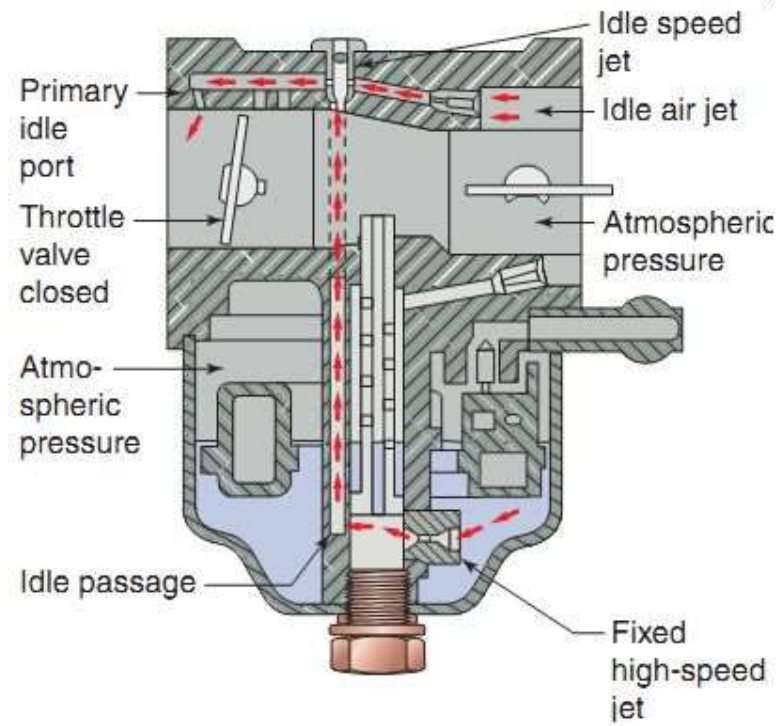
- Full throttle-
Maximum air
fuel flow to
develop full
speed and
power



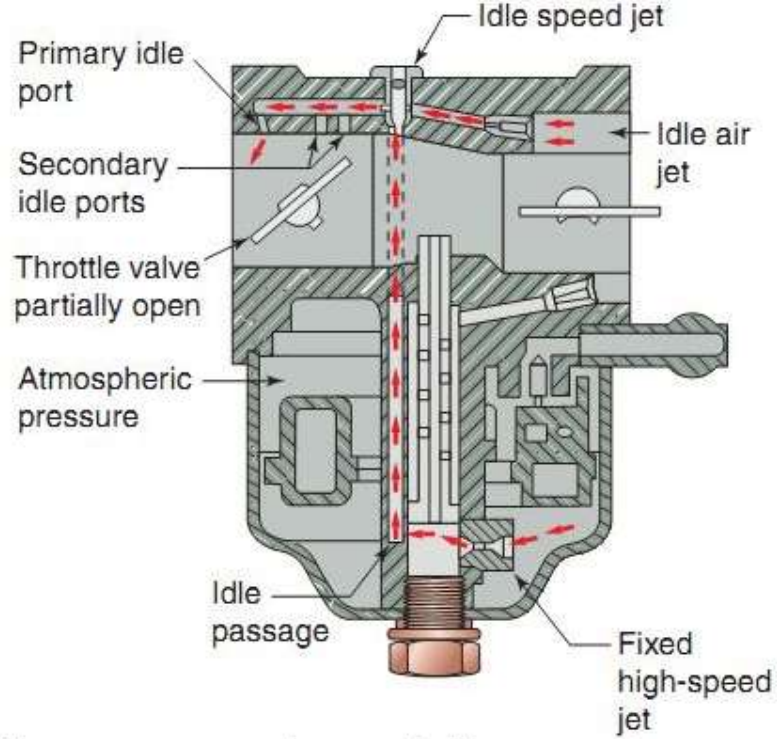
Accelerator-Pump Circuit

- When the throttle valve is suddenly opened, there is a corresponding sudden increase in the speed of the airflow through the carburetor. Because the air is lighter than the gasoline, it will accelerate quicker, causing a very lean mixture to reach the engine for a brief period. This would result in a severe lag in engine performance if not for the accelerator pump circuit. Its job is to inject a measured charge of gasoline into the carburetor throat whenever the throttle valve is opened.

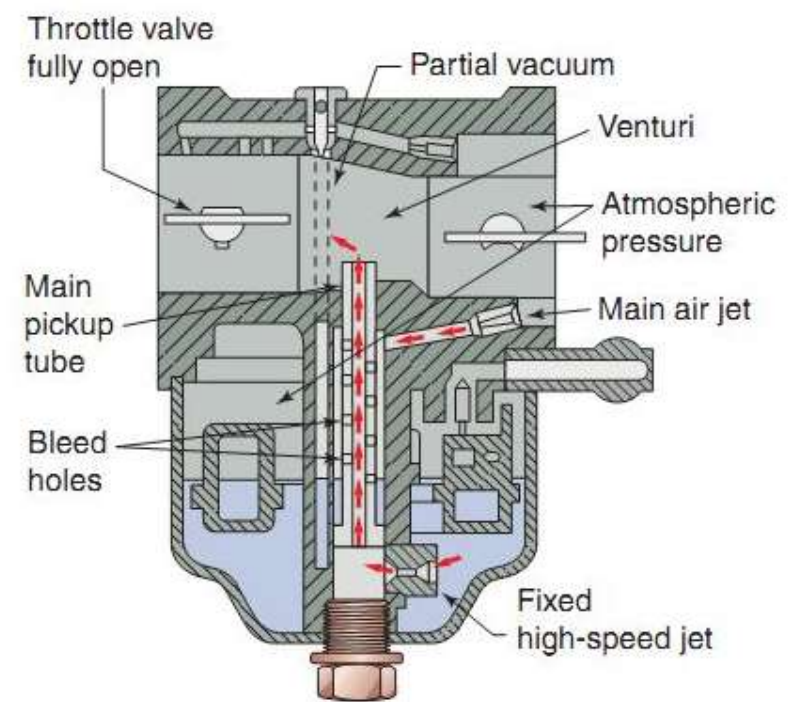




A typical idle circuit.



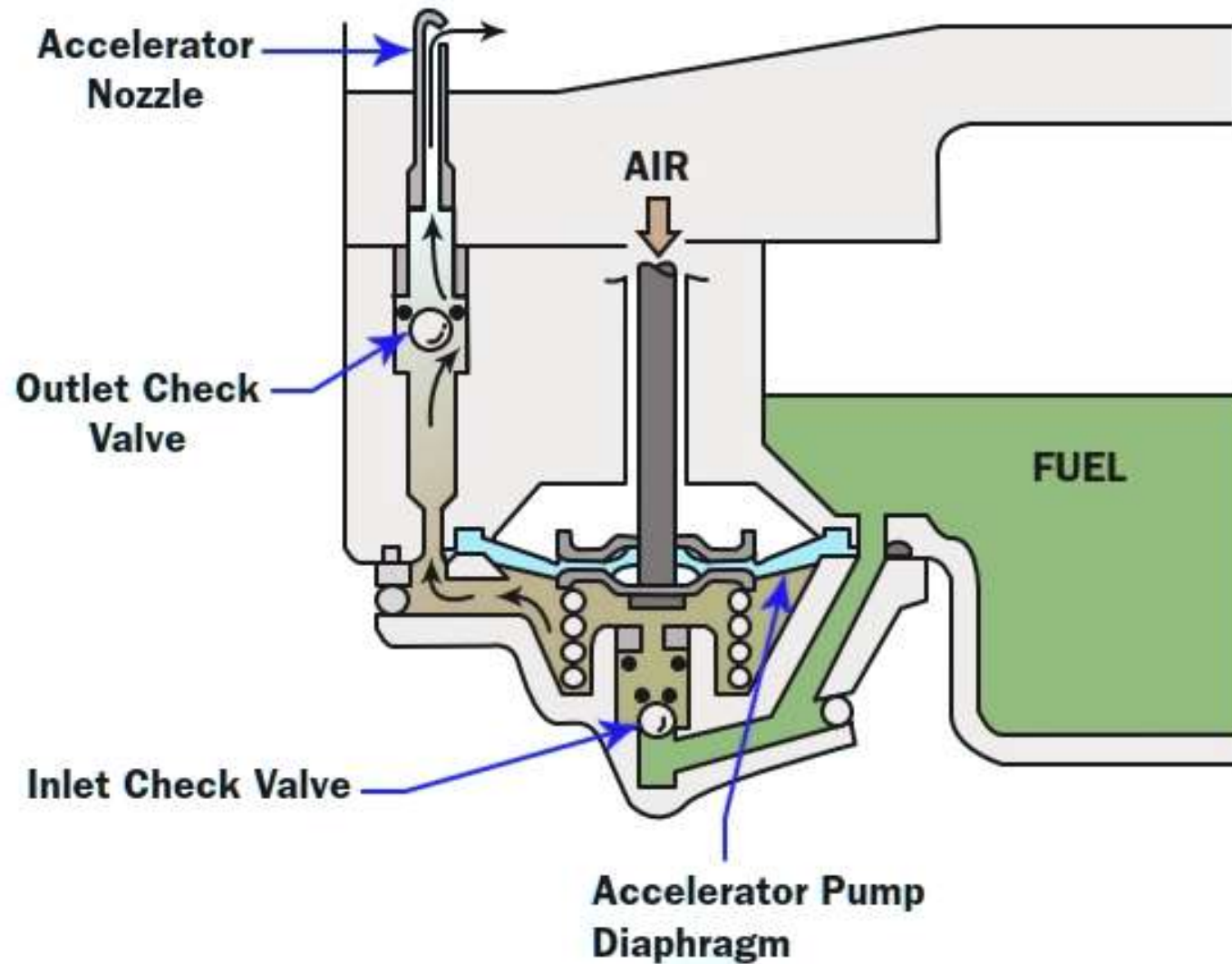
The secondary idle ports are used to assist when the user applies an increase in throttle



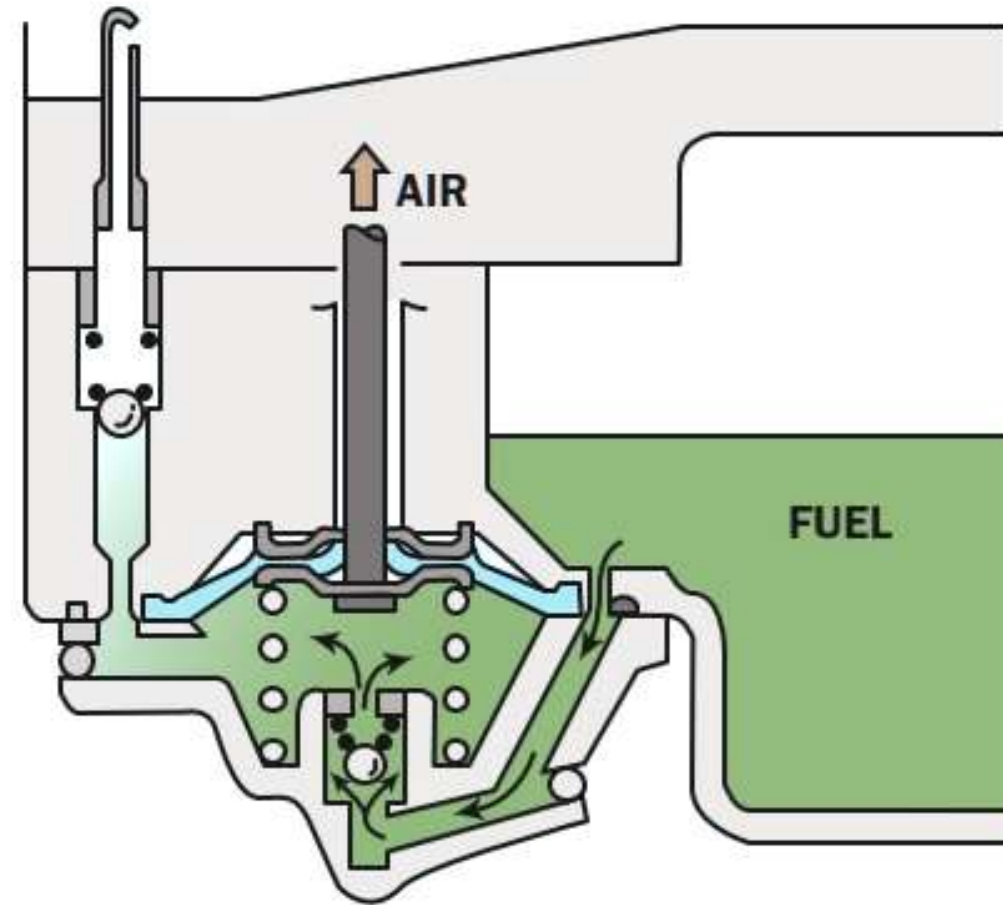
The high-speed circuit comes into play when the throttle valve is opened over half way

Accelerator-Pump Circuit

THROTTLE VALVE OPENS

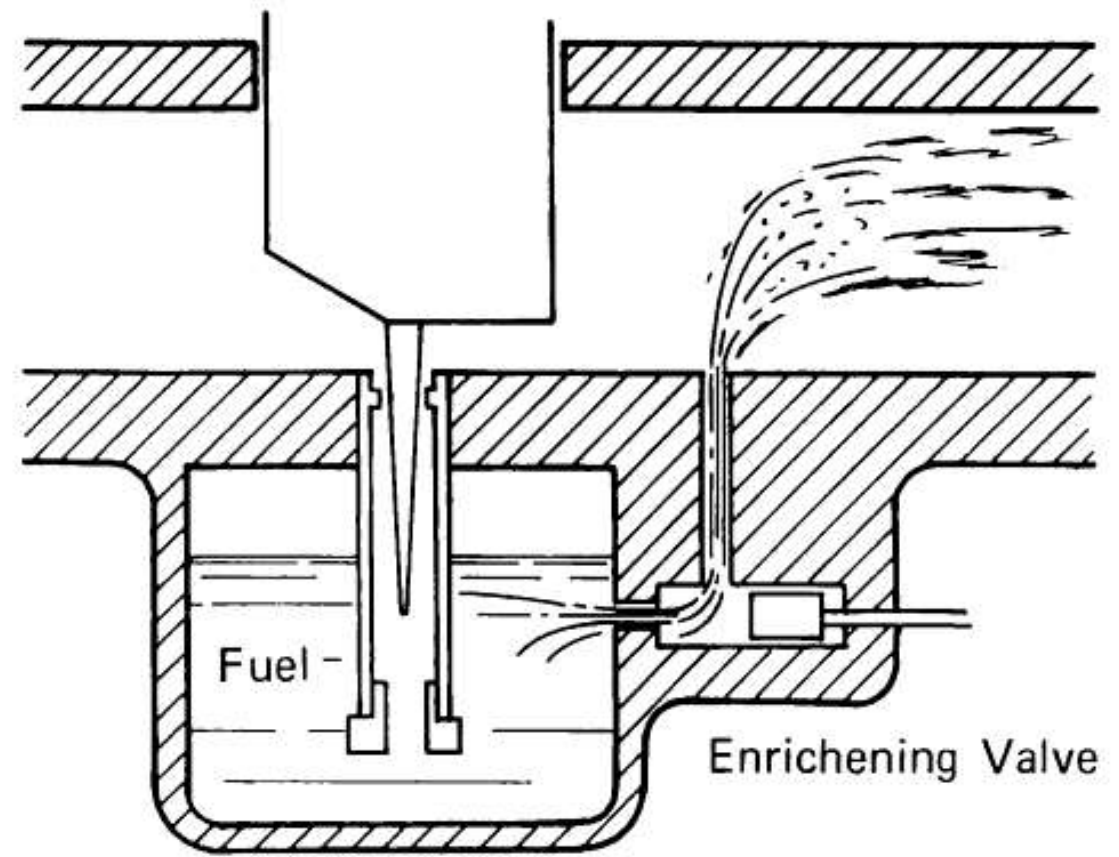


THROTTLE VALVE CLOSES



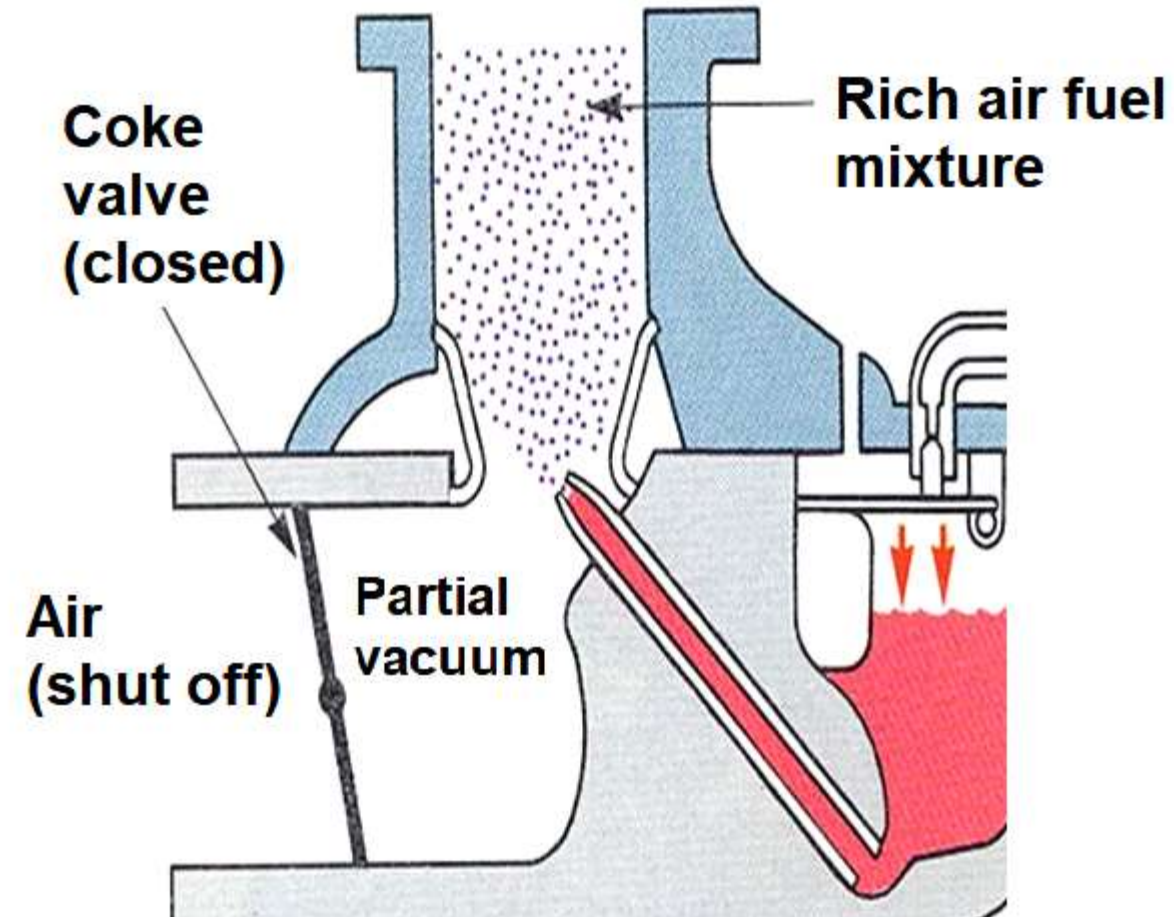
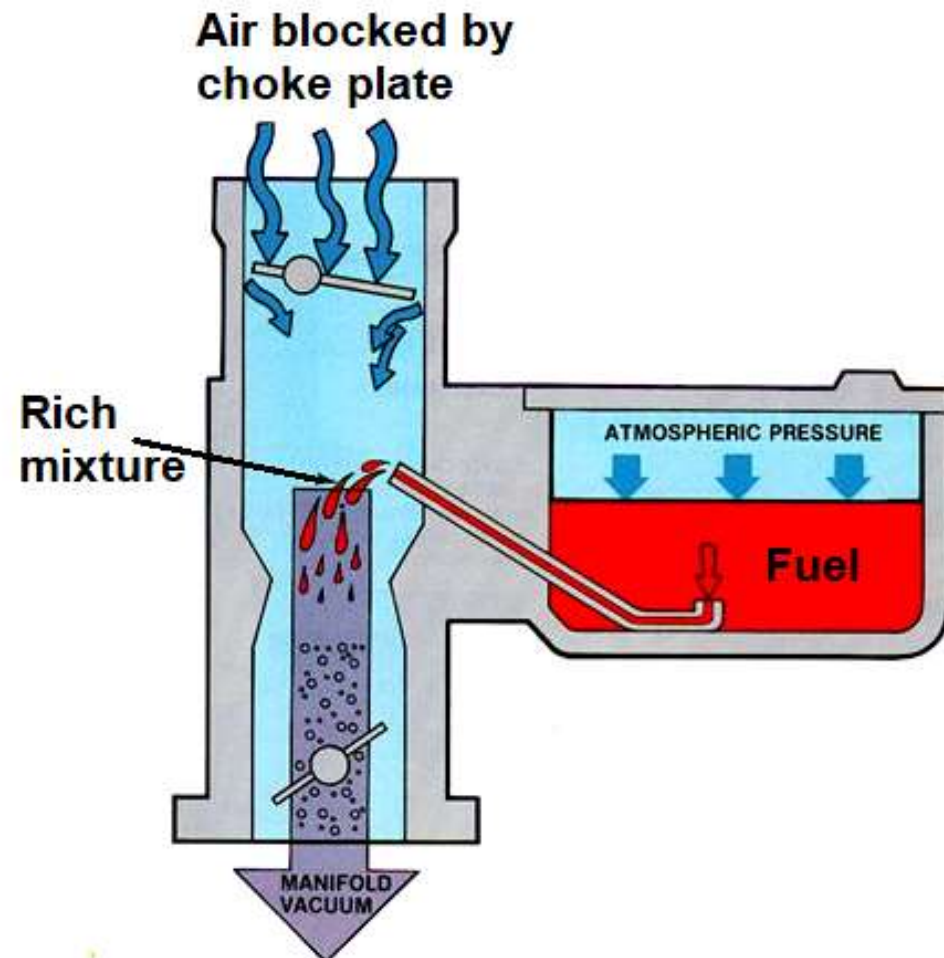
Cold-Start (Choke) Circuit

- The purpose of the choke is to deliver an enriched air-fuel mixture into the cold engine to help it start. Having a rich air to fuel ratio flowing into the cold engine helps it start when cold. By having more fuel flowing into the cylinder, there is a higher chance of ignition

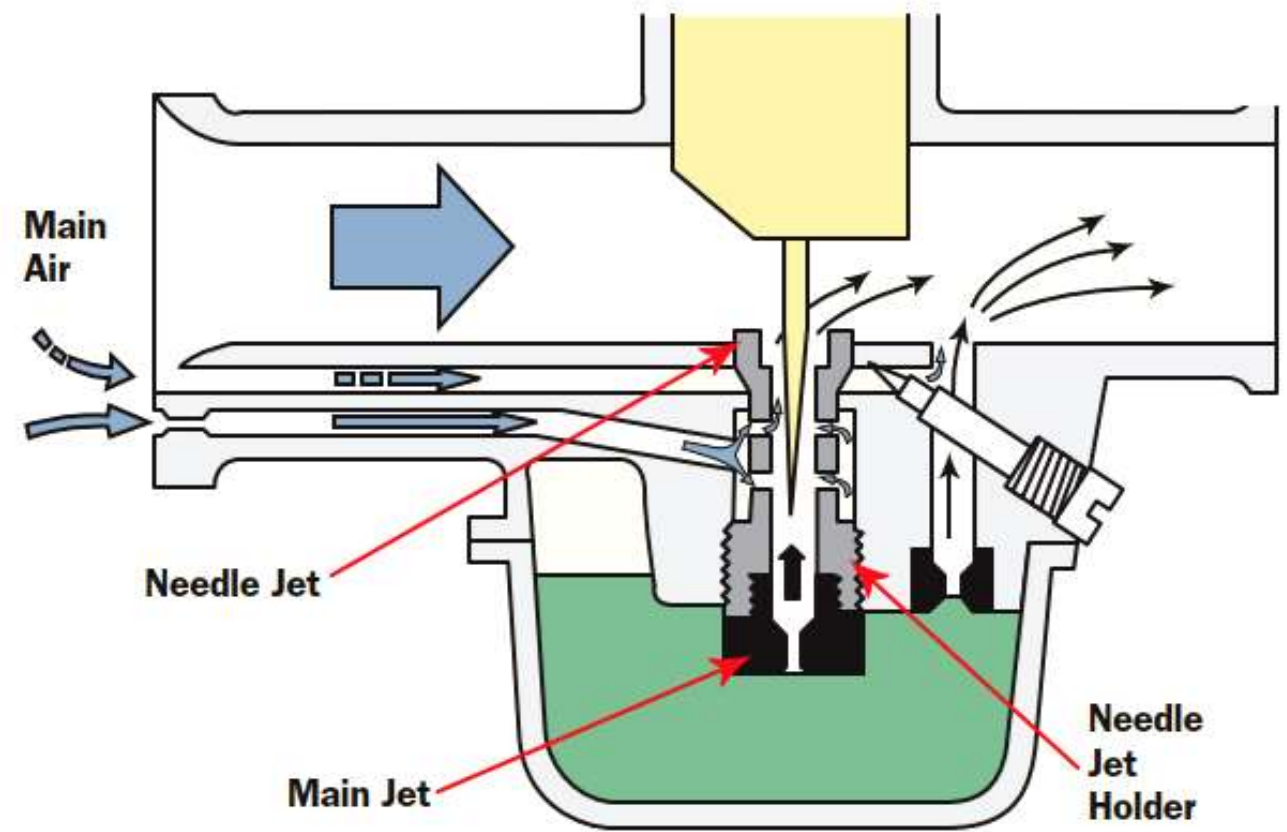
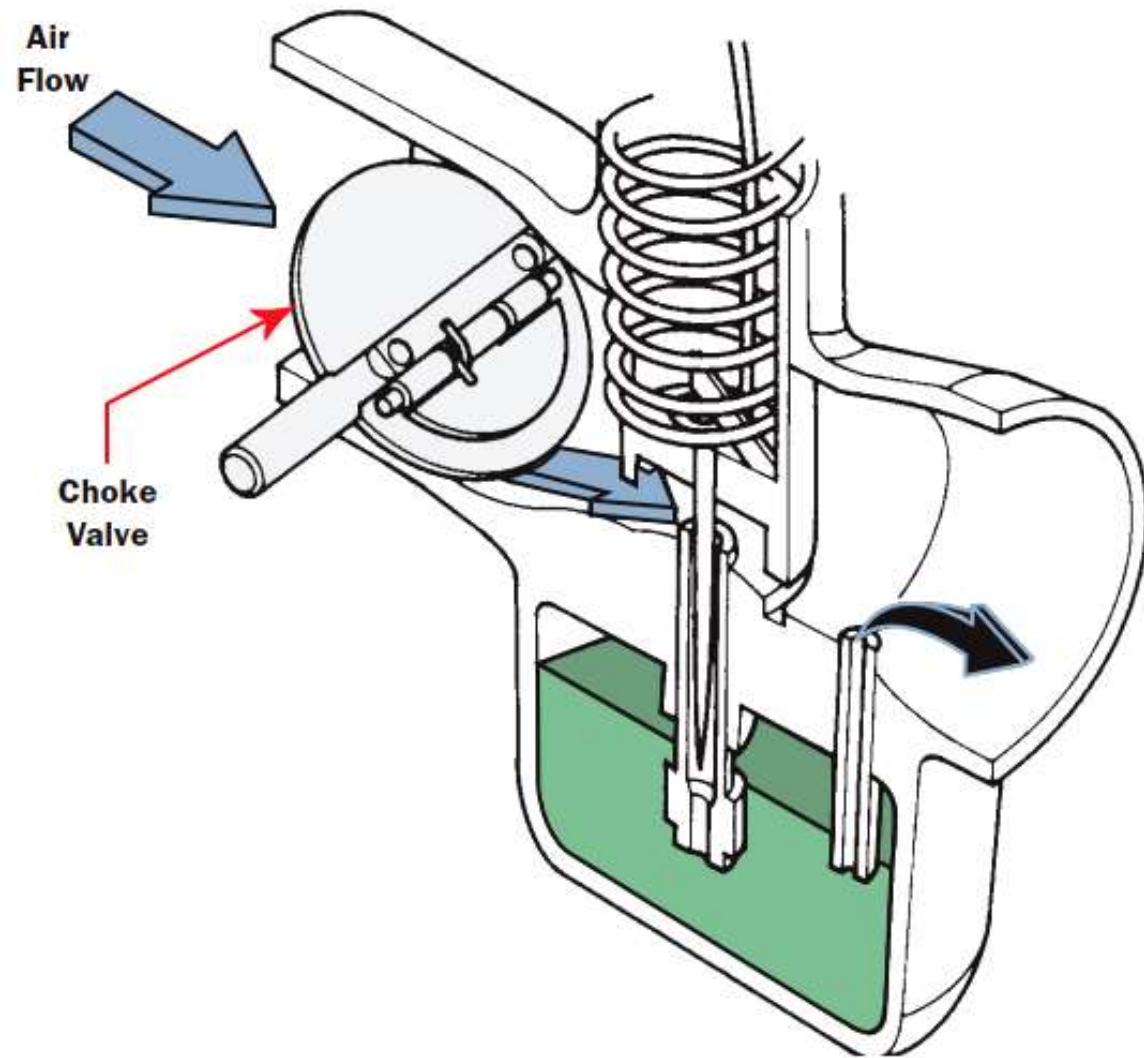


enriching valve, many manufactures use a seperate passeage to enrich the air fuel mixture for starting and warm up

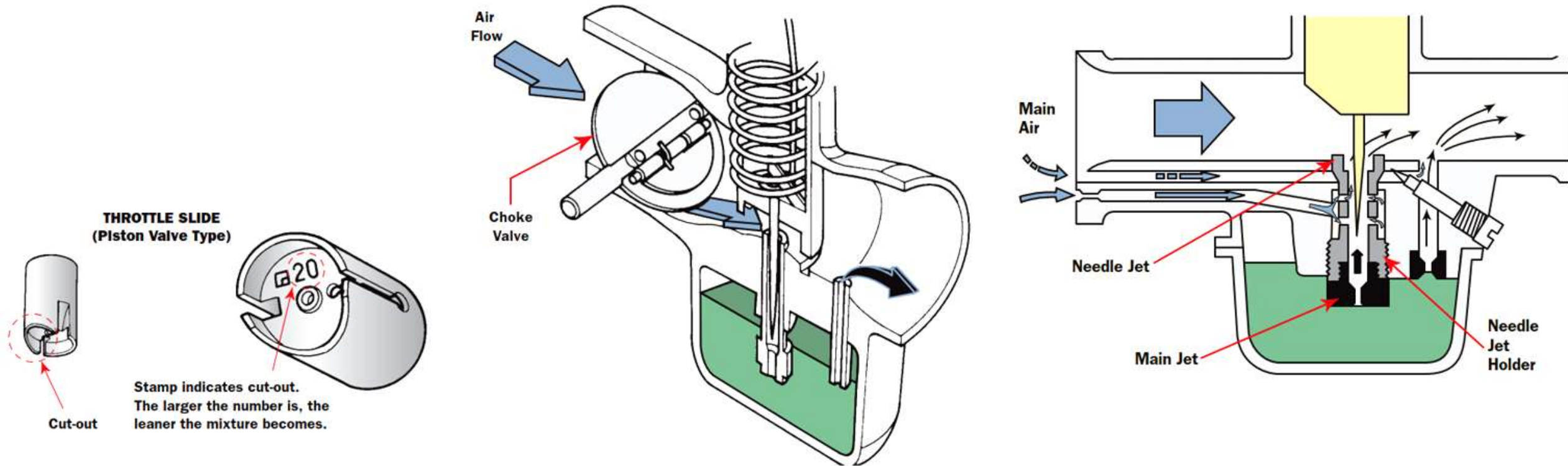
- When the engine is cold , Fuel doesn't vaporize well. More fuel must be added to overcome the problem.
- The choke closes the carburetor off from atmospheric pressure, causing the engine vacuum to pull extra fuel from the main circuit at idle.



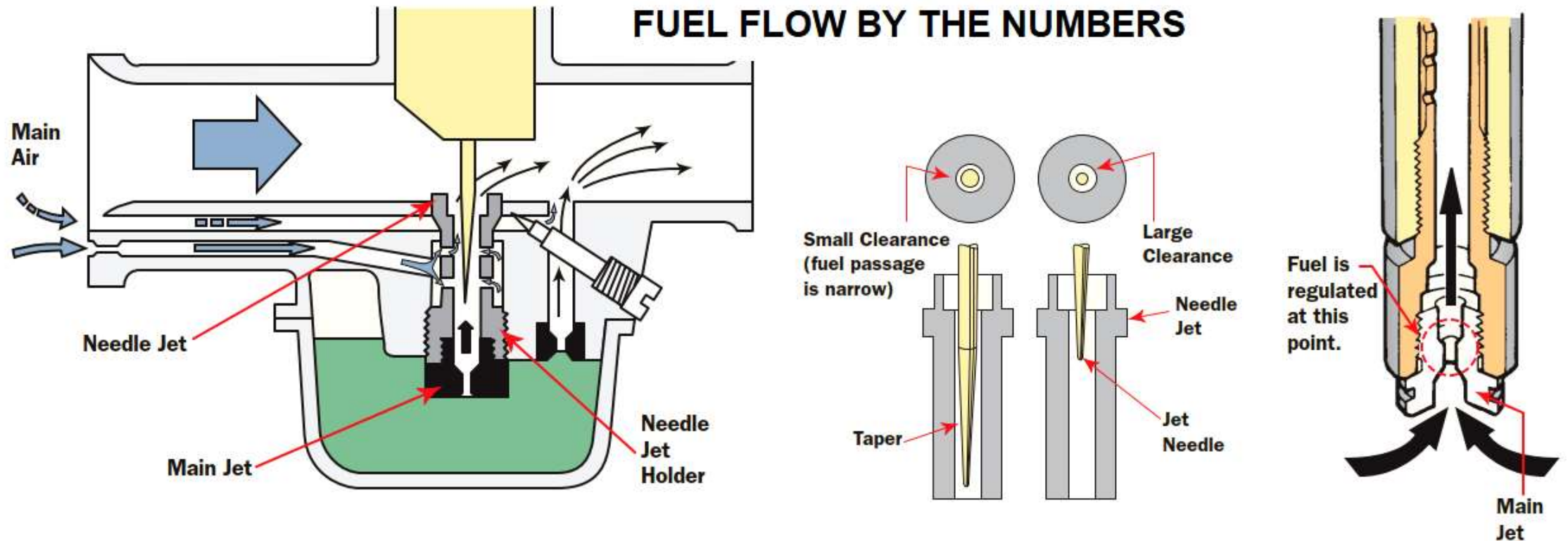
HOW CARB CIRCUITS WORK TOGETHER



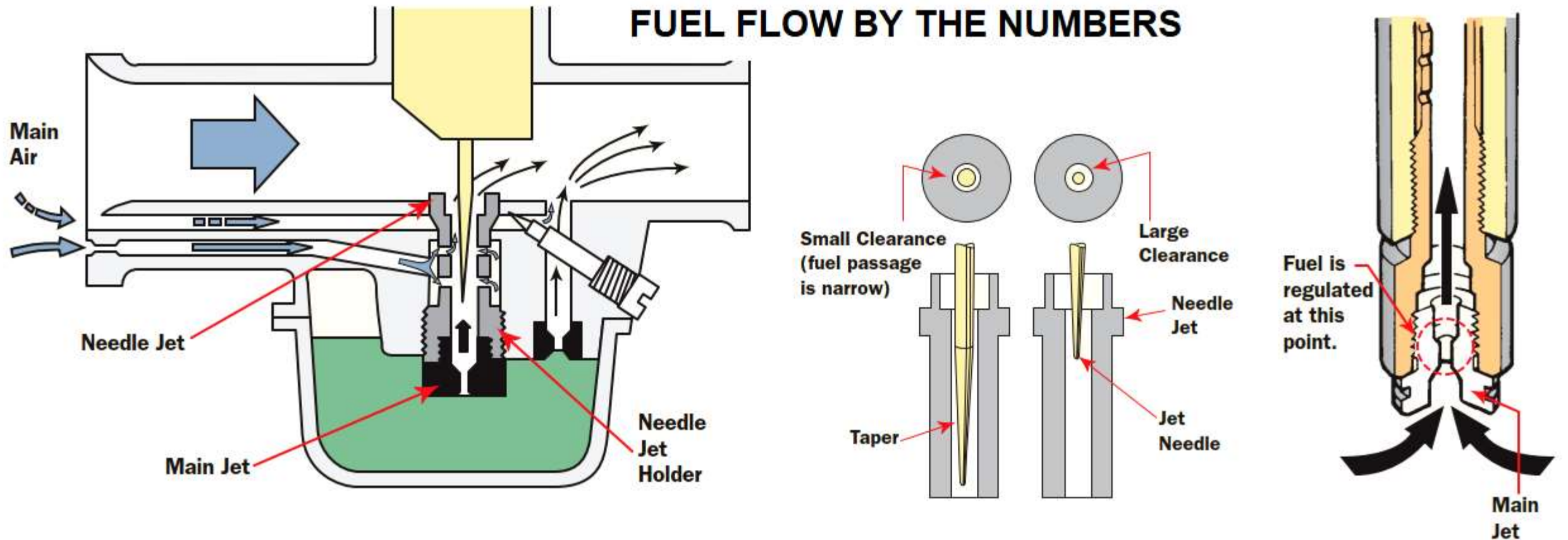
At very low engine speeds, from zero throttle opening to 1/8 throttle, fuel flow is regulated by the pilot or slow speed circuit. At any speed above that the carburetor's main fuel circuit is utilized. Here's how it works: When the throttle is opened past idle a greater amount of fuel and air is obviously required. From 1/8 to 1/2 throttle airflow through the carburetor venturi creates low pressure above the discharge tube (needle jet holder). This allows atmospheric pressure to act on the fuel in the float bowl and force it past the gap between the needle jet and the jet needle.



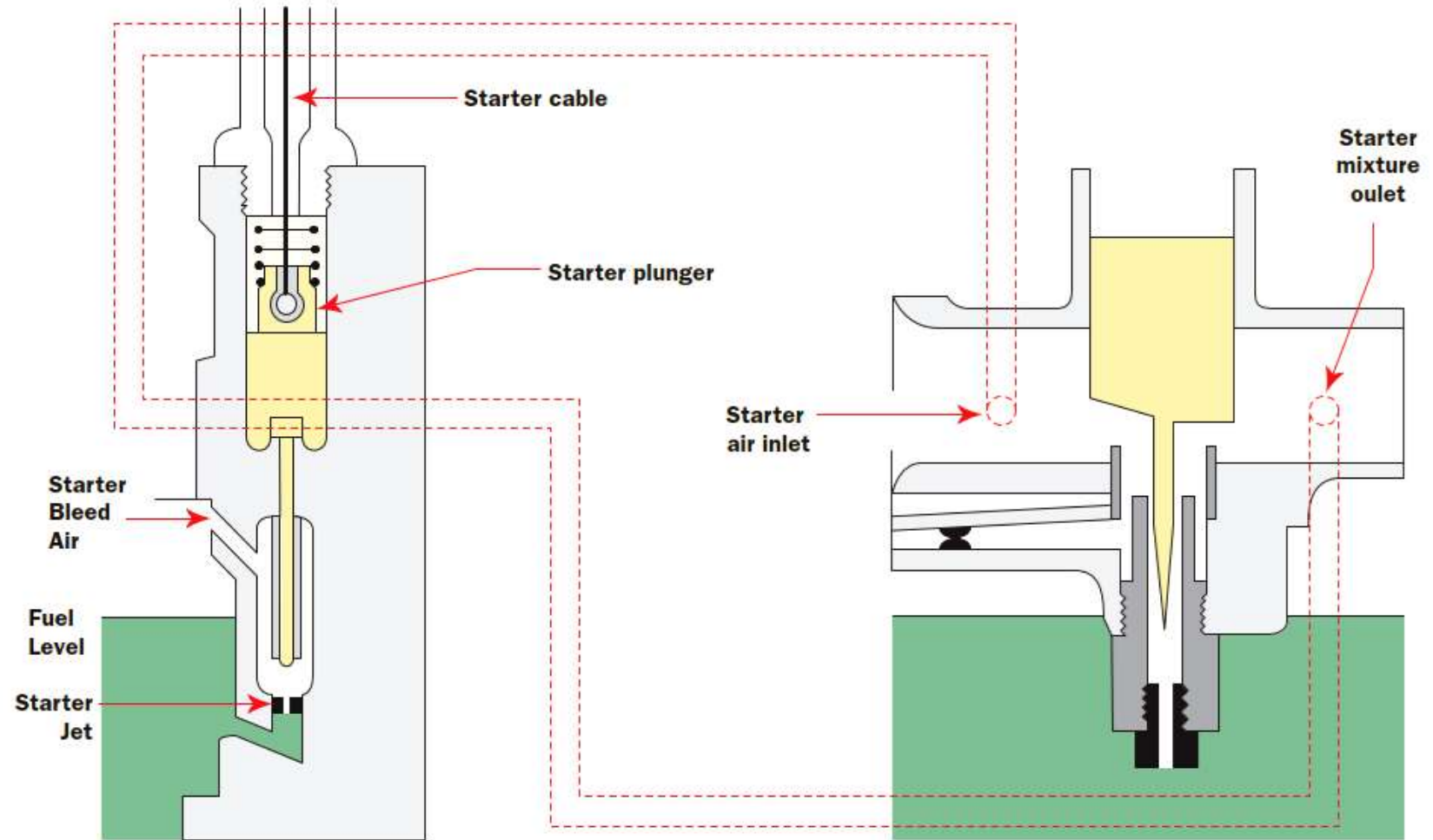
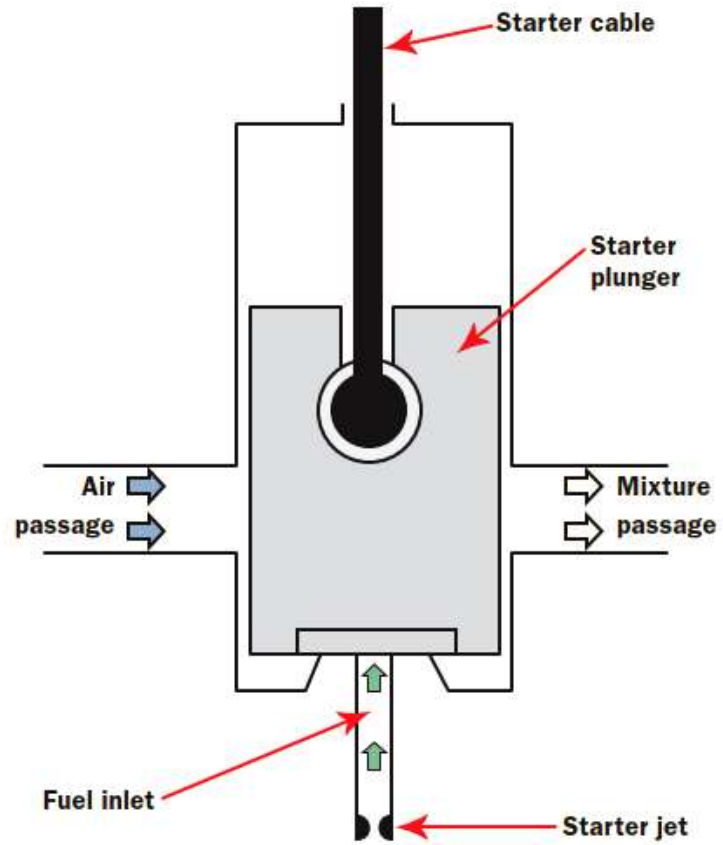
As the throttle opens past 1/4, the taper of the needle begins to play a greater part. As you can see from the illustration the needle is tapered, consequently the higher it rides in the jet, the more fuel it allows to pass through the jet. On some carburetors the needle adjustment may be fine tuned by raising or lowering the small clip that positions the needle. Lowering the clip causes the needle to ride slightly higher creating a richer mixture and vice versa.



Above 3/4 throttle the needle is nearly withdrawn from the needle jet. At that point fuel delivery is regulated by the main jet. Although it may not be obvious there is some overlap between the various jet circuits as they make the transition from idle to wide open throttle.

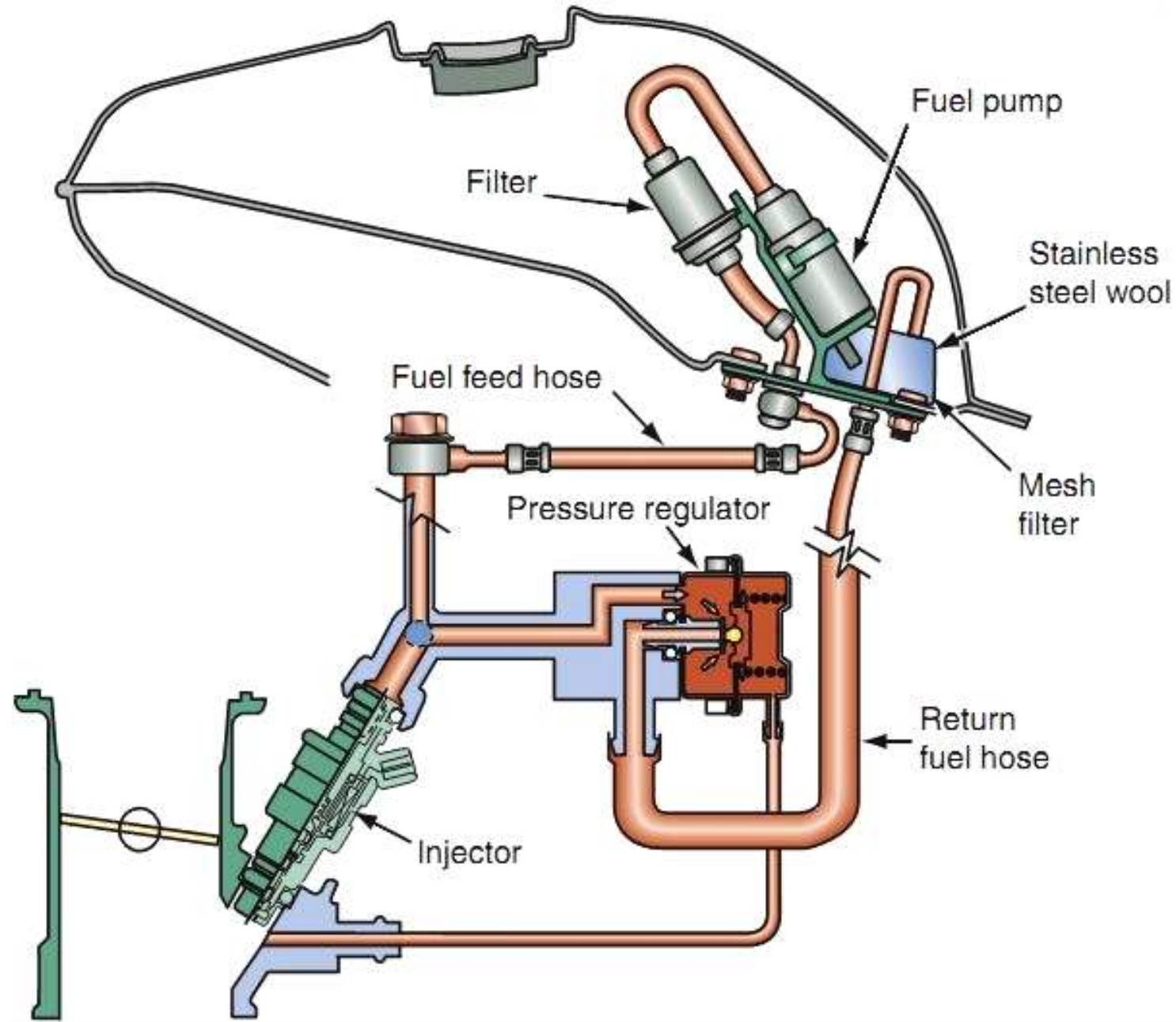


STARTER CARBURETOR

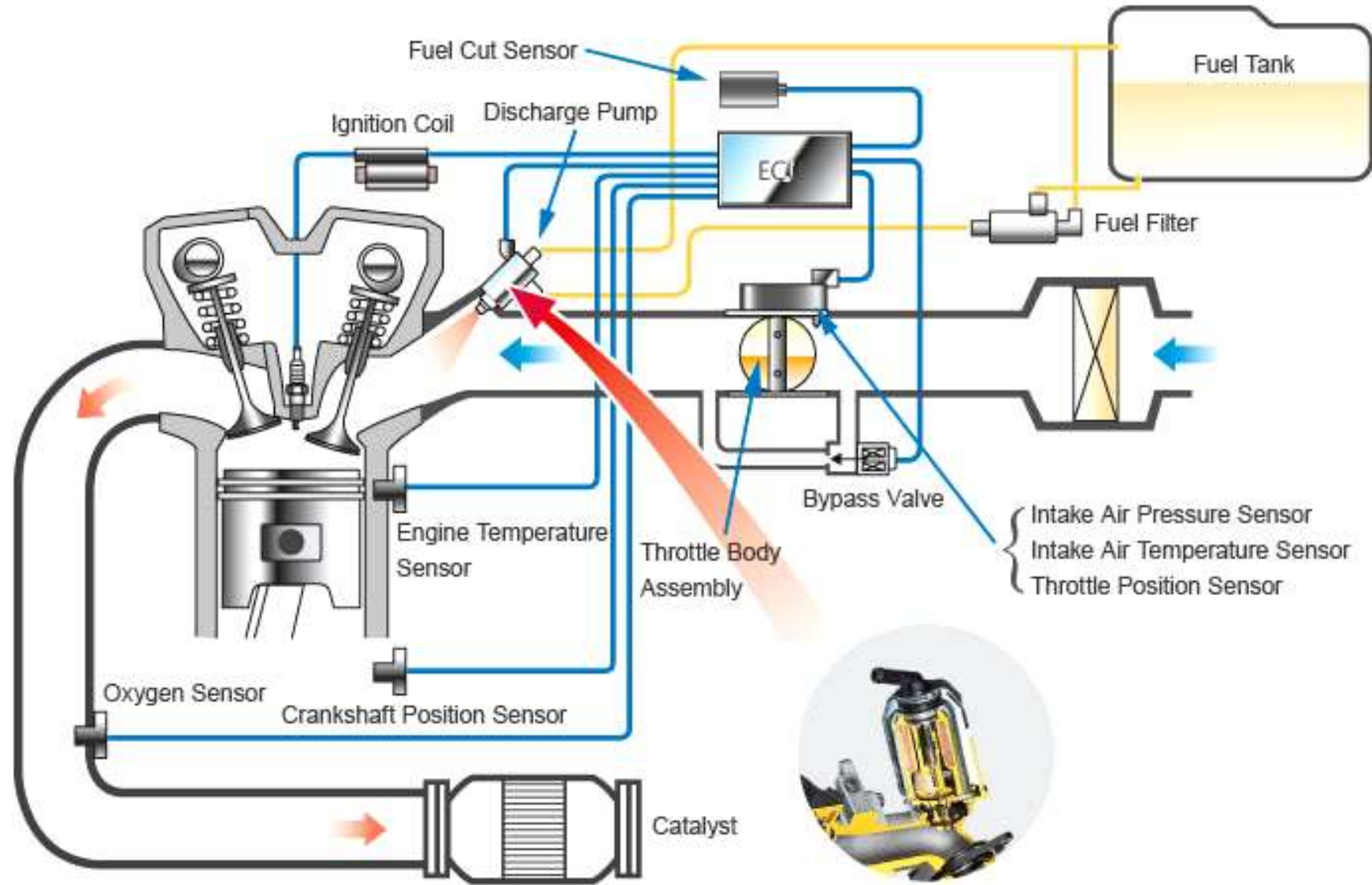


FUEL-INJECTION SYSTEM

- In a fuel injection system, a computer controls the intake of air and fuel and commands the fuel injectors to spray the mixture directly into the combustion chamber and engine, so no fuel gets wasted. It's much more efficient, and all newer bikes come with fuel injection by default.



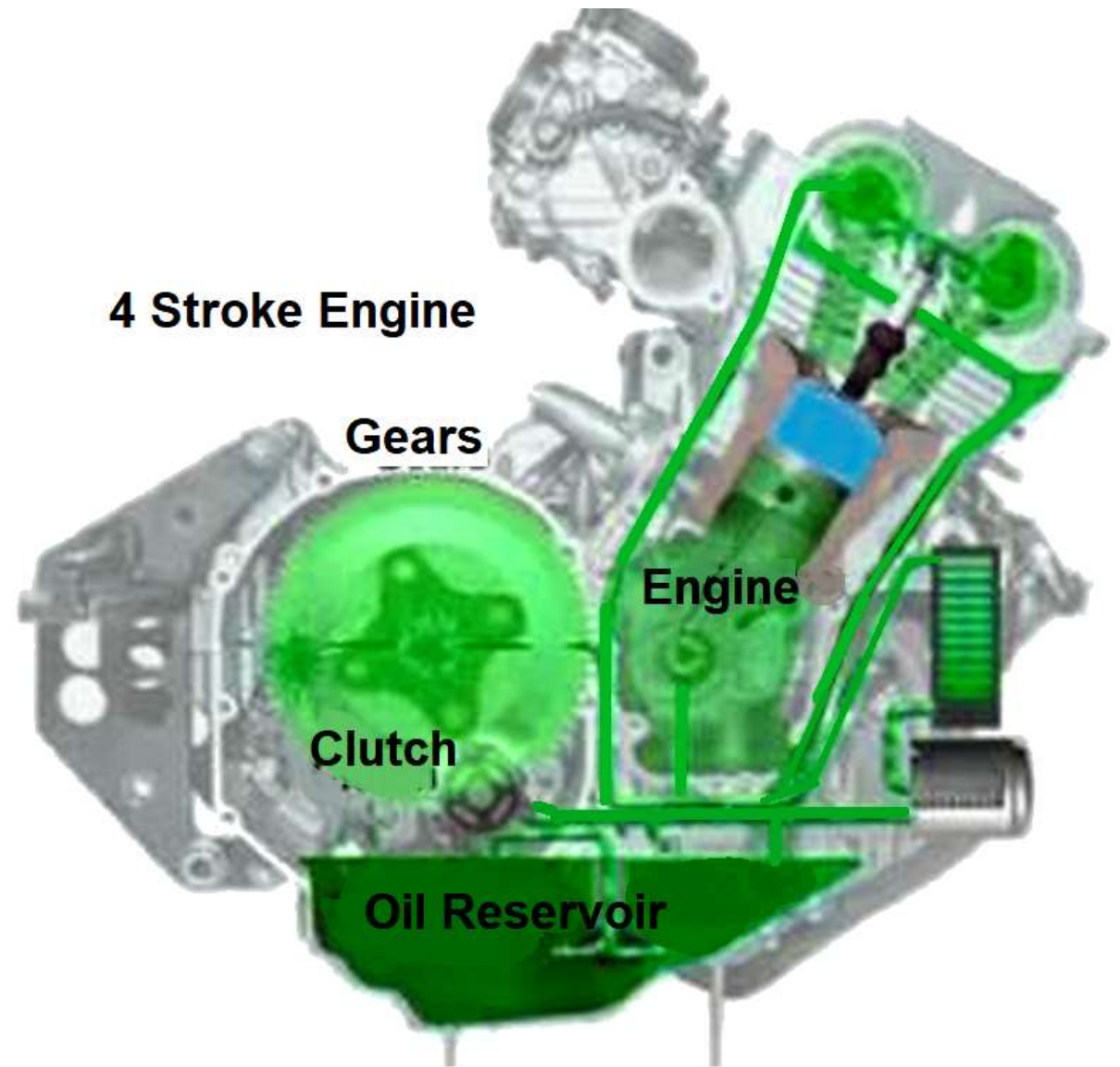
- An **electronic control unit (ECU)**, also known as an **electronic control module (ECM)**, is an embedded system (**computer**) in bike/automotive electronics that controls one or more of the electrical systems or subsystems. Such as Ignition..etc.



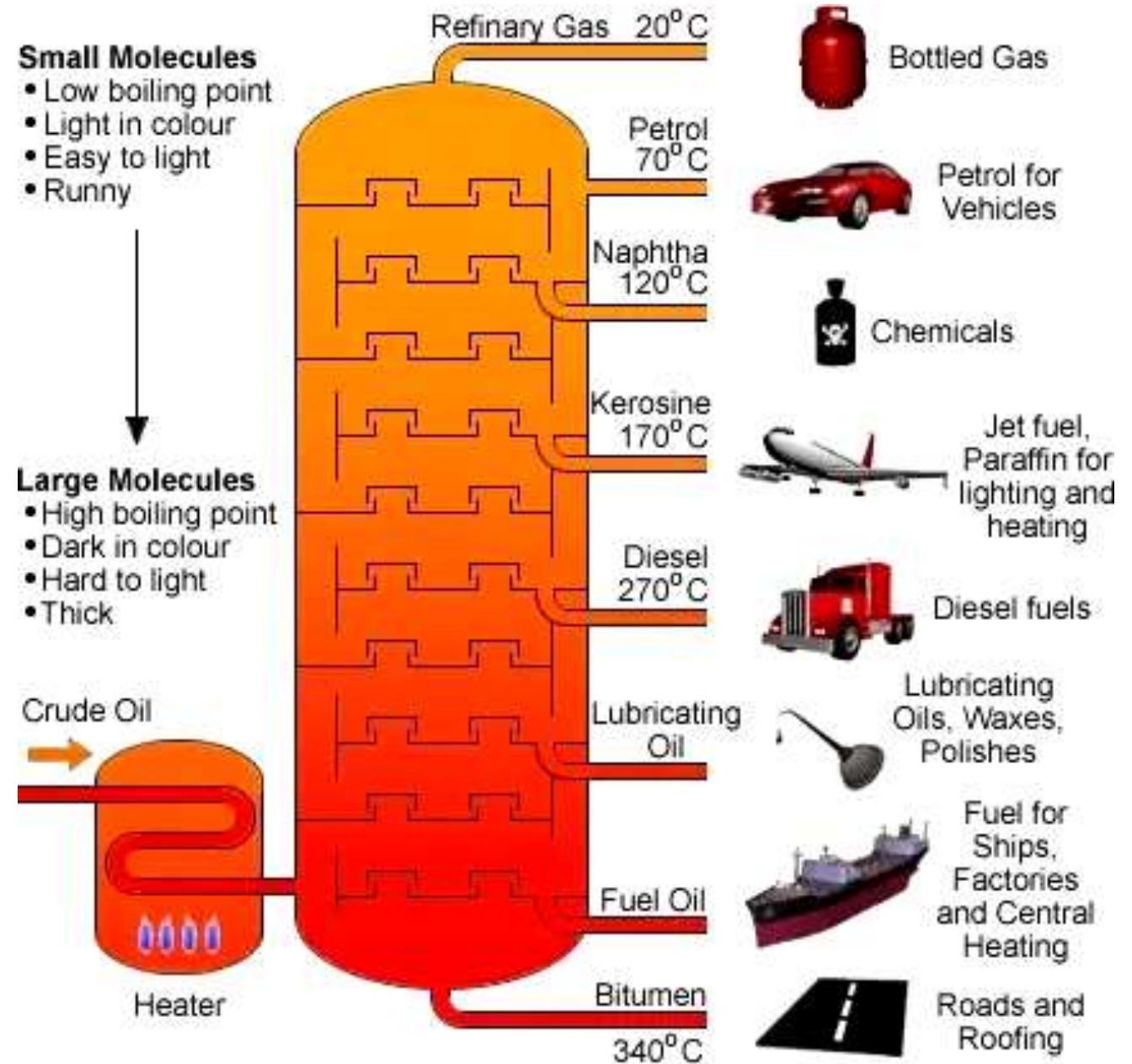
Motorcycle Lubrication

- Engine oil lubricates two moving parts by covering these parts with a slick film. The lubrication system must provide a continuous flow of oil to all the engine parts so that the oil film on each component is maintained to minimize wear. The correct oil viscosity is also essential for reducing friction

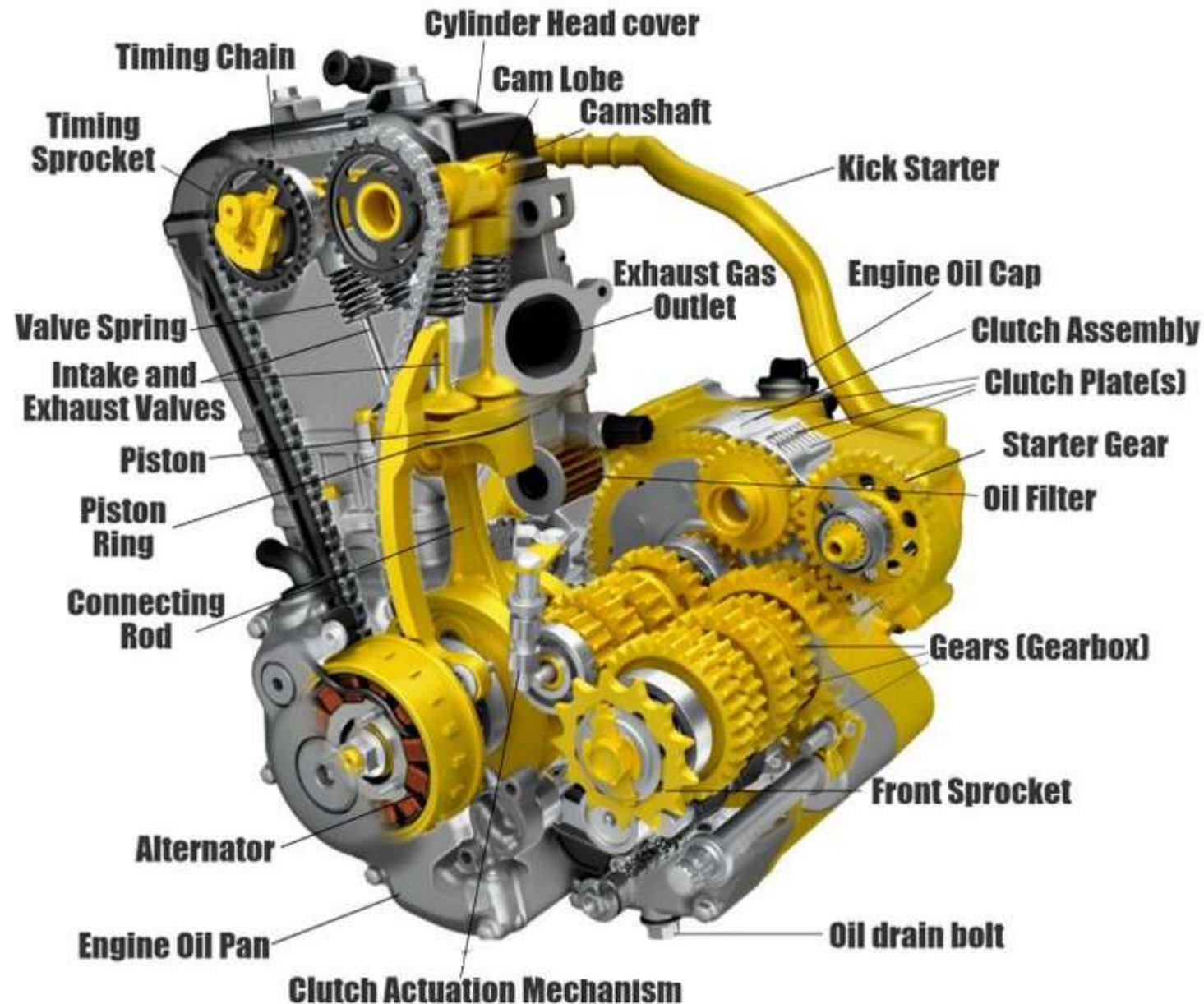




- For some common grades of motorcycle engine oil, there is a choice of products available including mineral, semi-synthetic and synthetic oils. Mineral motor oils are refined from natural **crude oil**. Synthetic motor oils are man-made fluids manufactured from uniform oil molecules (also initially refined from crude oil)



- Motorcycle manufacturers typically require higher viscosity oils than passenger cars. Motorcycles often call for grades such as 5W-40, 10W-40, 10W-50 and 20W-50. As with cars,



- **Motorcycle** Parts that require lubrication using grease are wheel bearing grease for the wheel bearings, steering stem bearings, and swing arm pivot. Clutch, brake, and speedometer cables need fairly thin grease



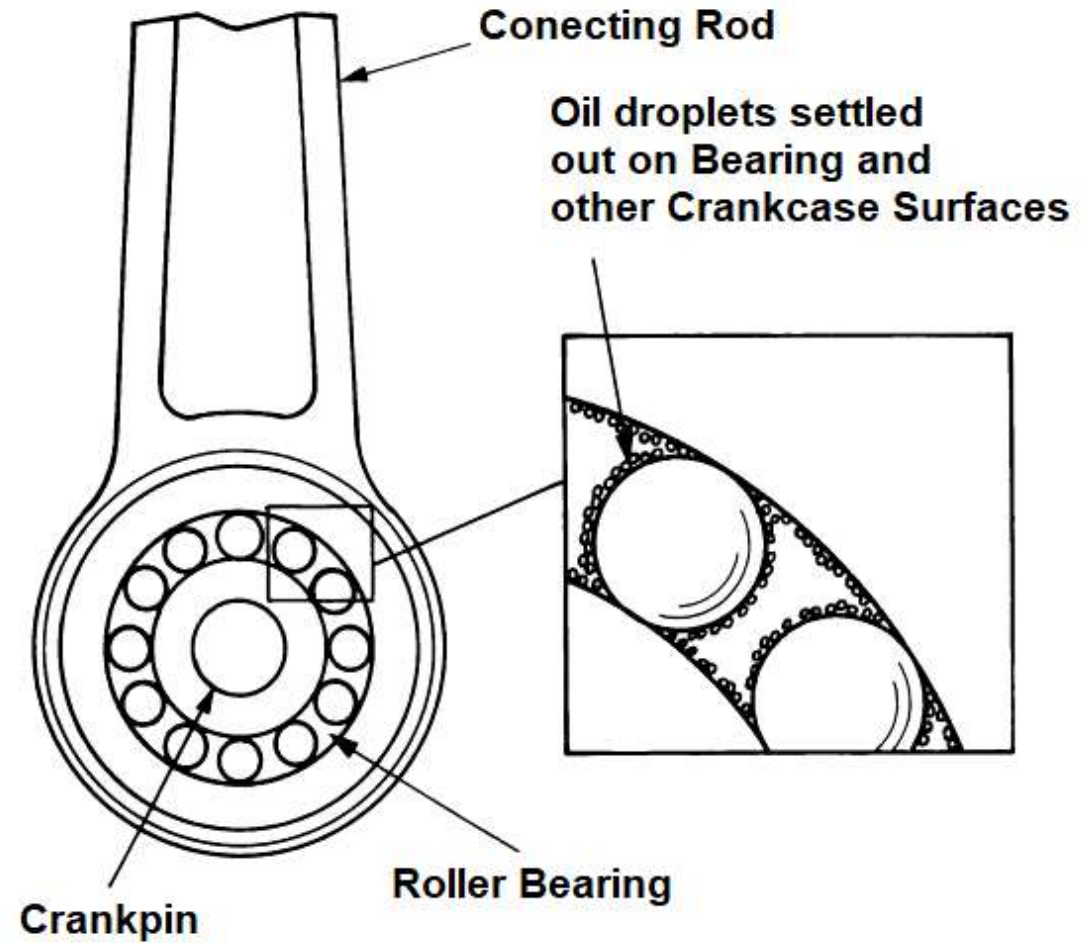
- Chain Lubrication Is very important. A dry chain that causes metal on metal friction wears significantly quicker than one that isn't lubricated



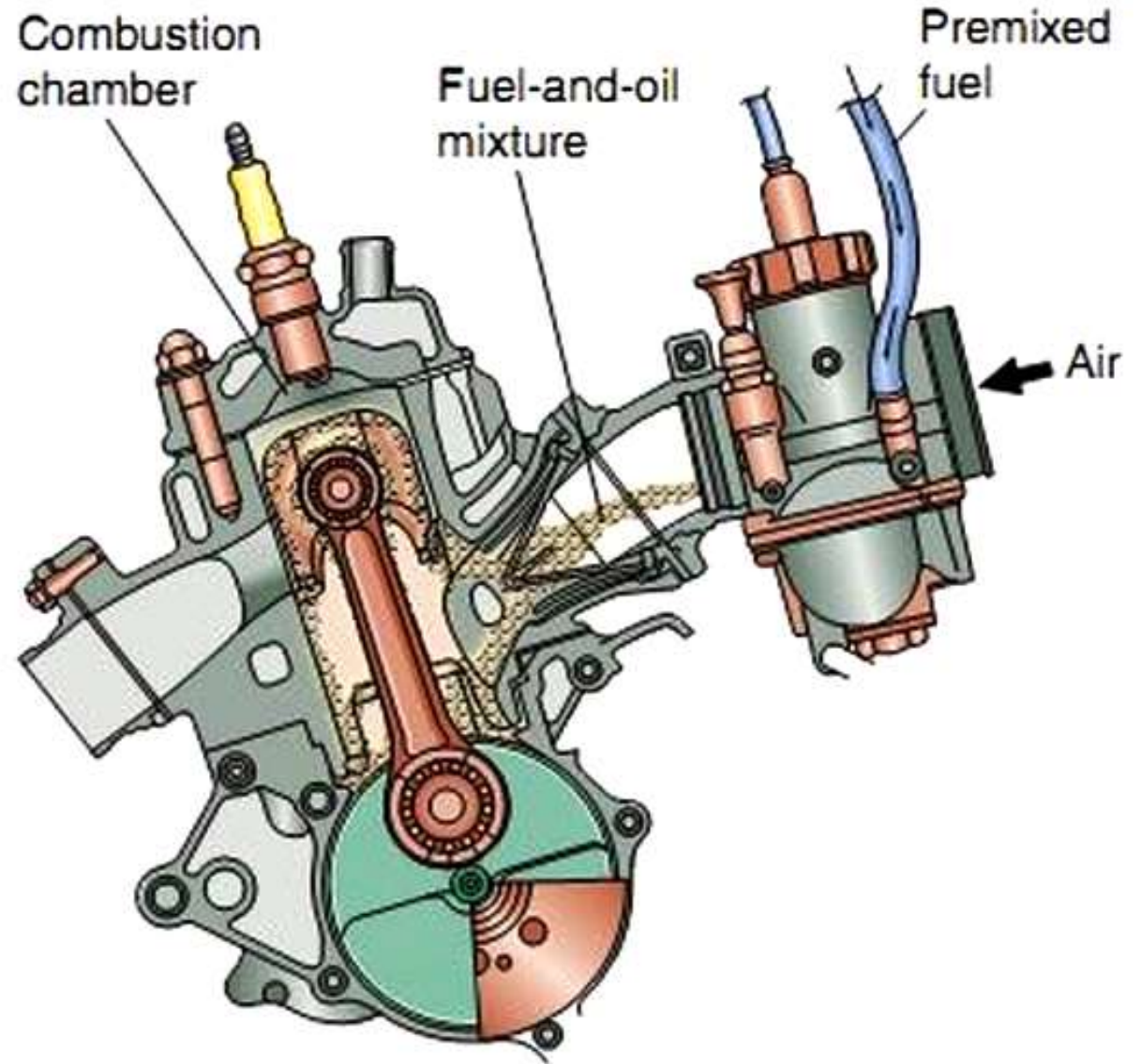
Two Stroke Lubrication Systems

Pre Mix

- Unlike a four-stroke engine, the crankcase of which is closed except for its ventilation system, a two-stroke engine uses the crankcase as part of the induction tract, so oil must be mixed with gasoline to be distributed throughout the engine for lubrication. The resultant mix is referred to as premix.

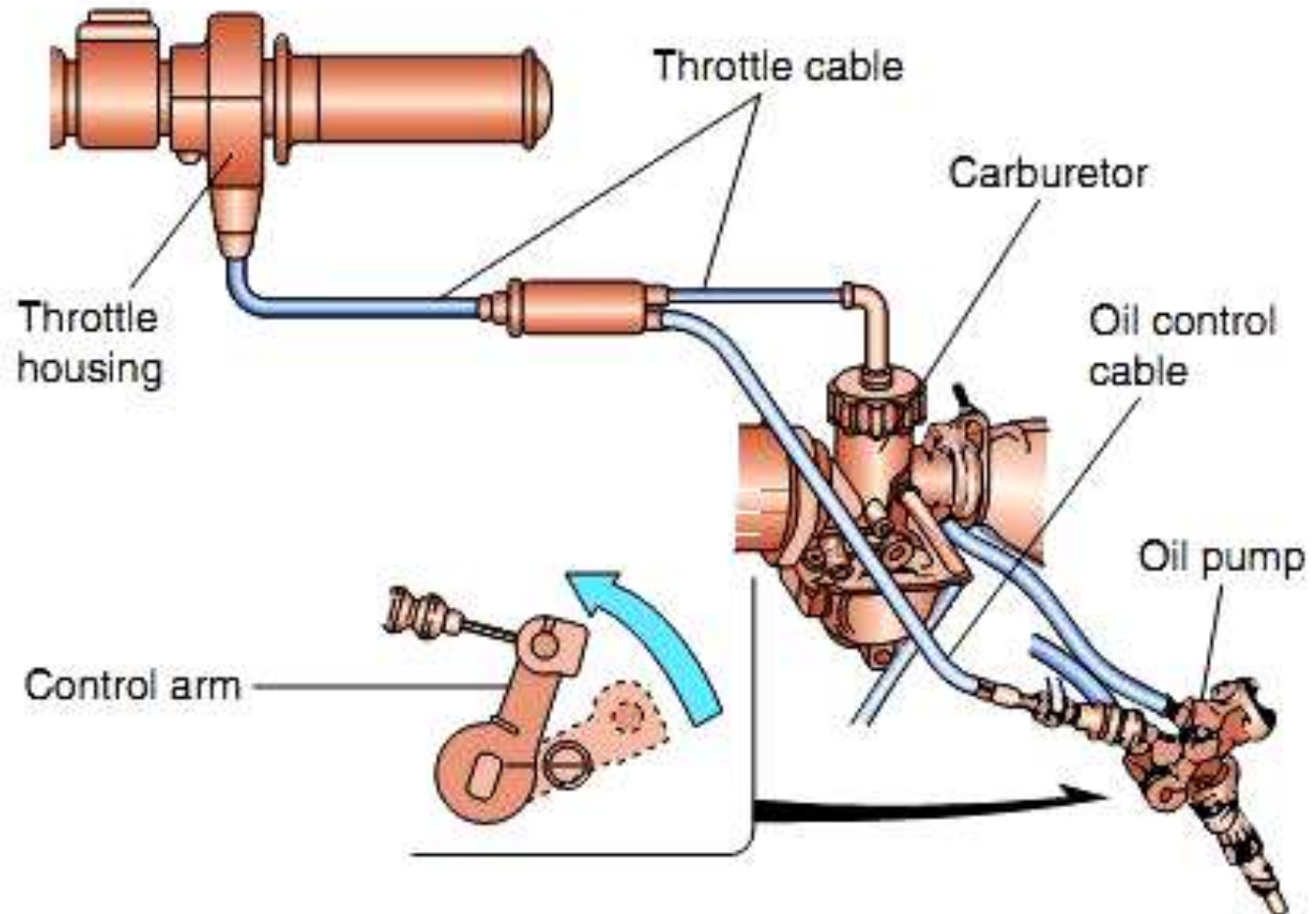
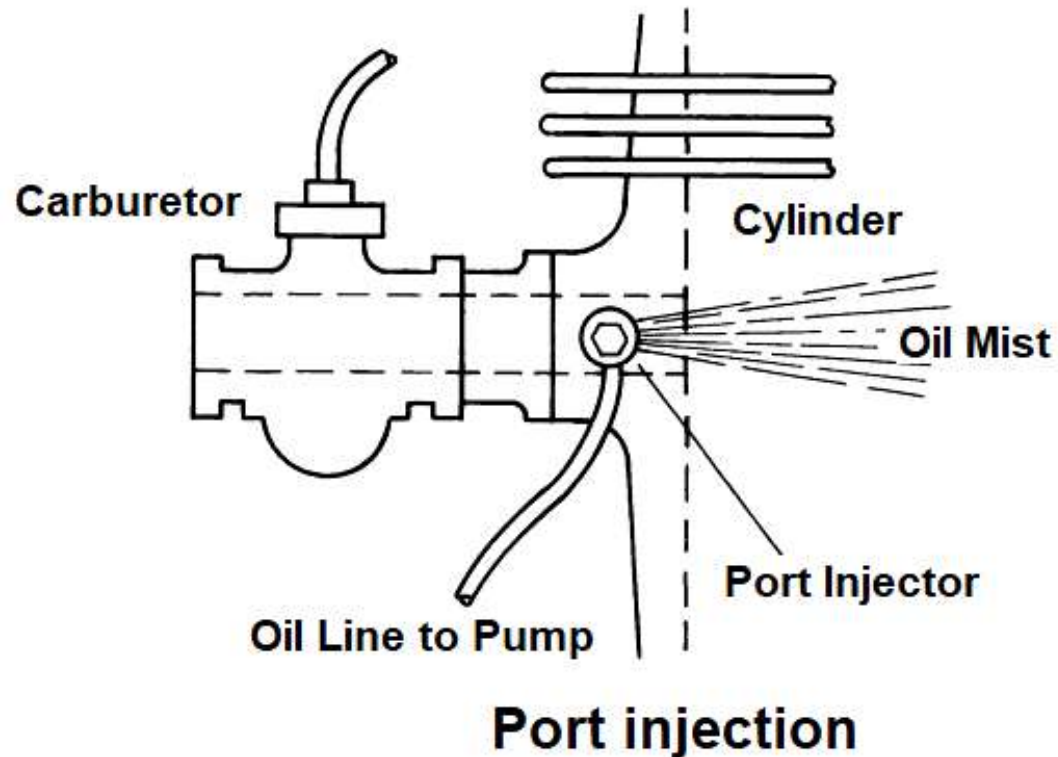


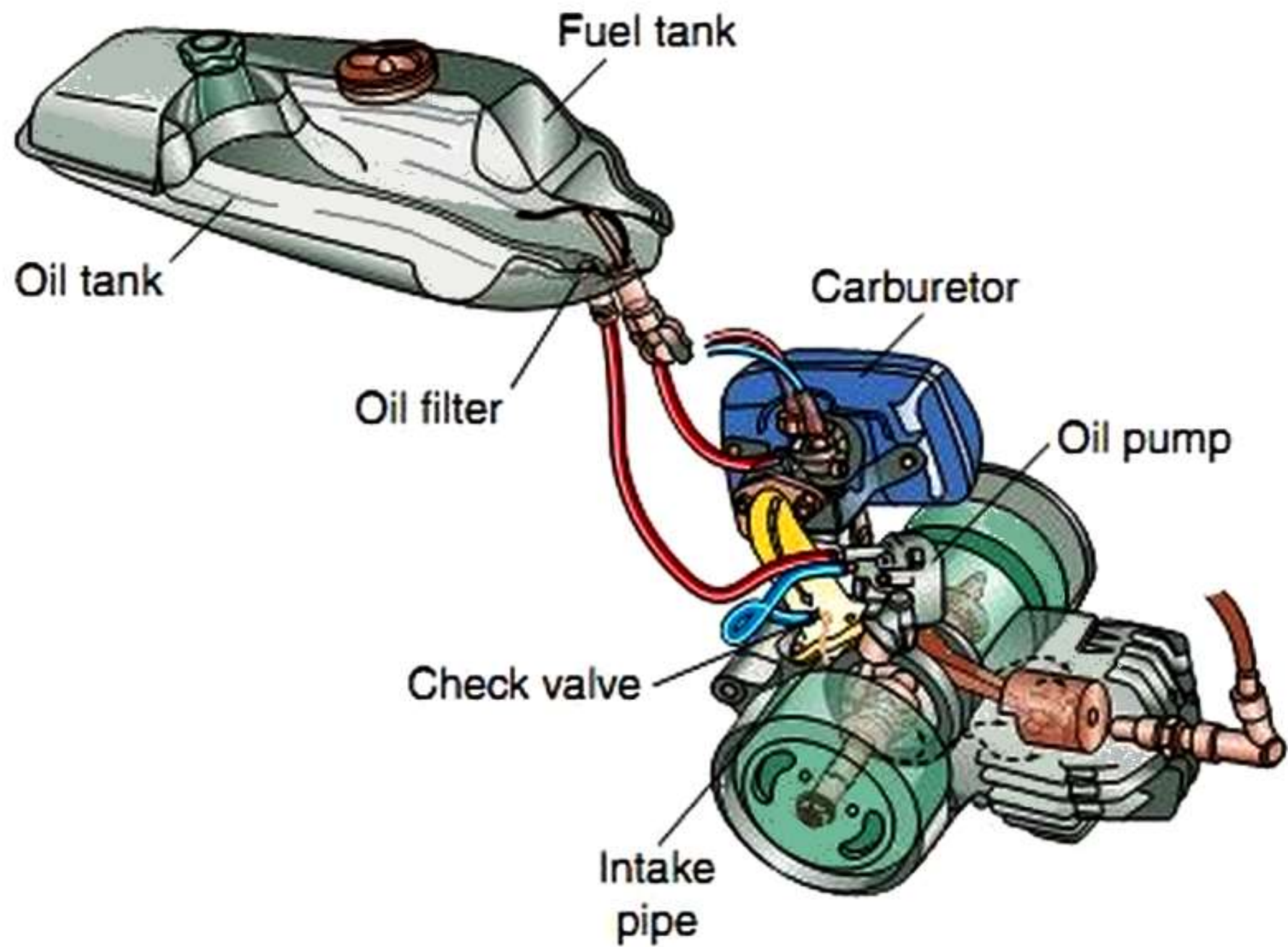
- The oil is ultimately burned along with the fuel as a total-loss oiling system. That results in increased exhaust emissions, sometimes with excess smoke and/or a distinctive odor. This is very old system but some old or simple motorcycles and mopeds still Use this method



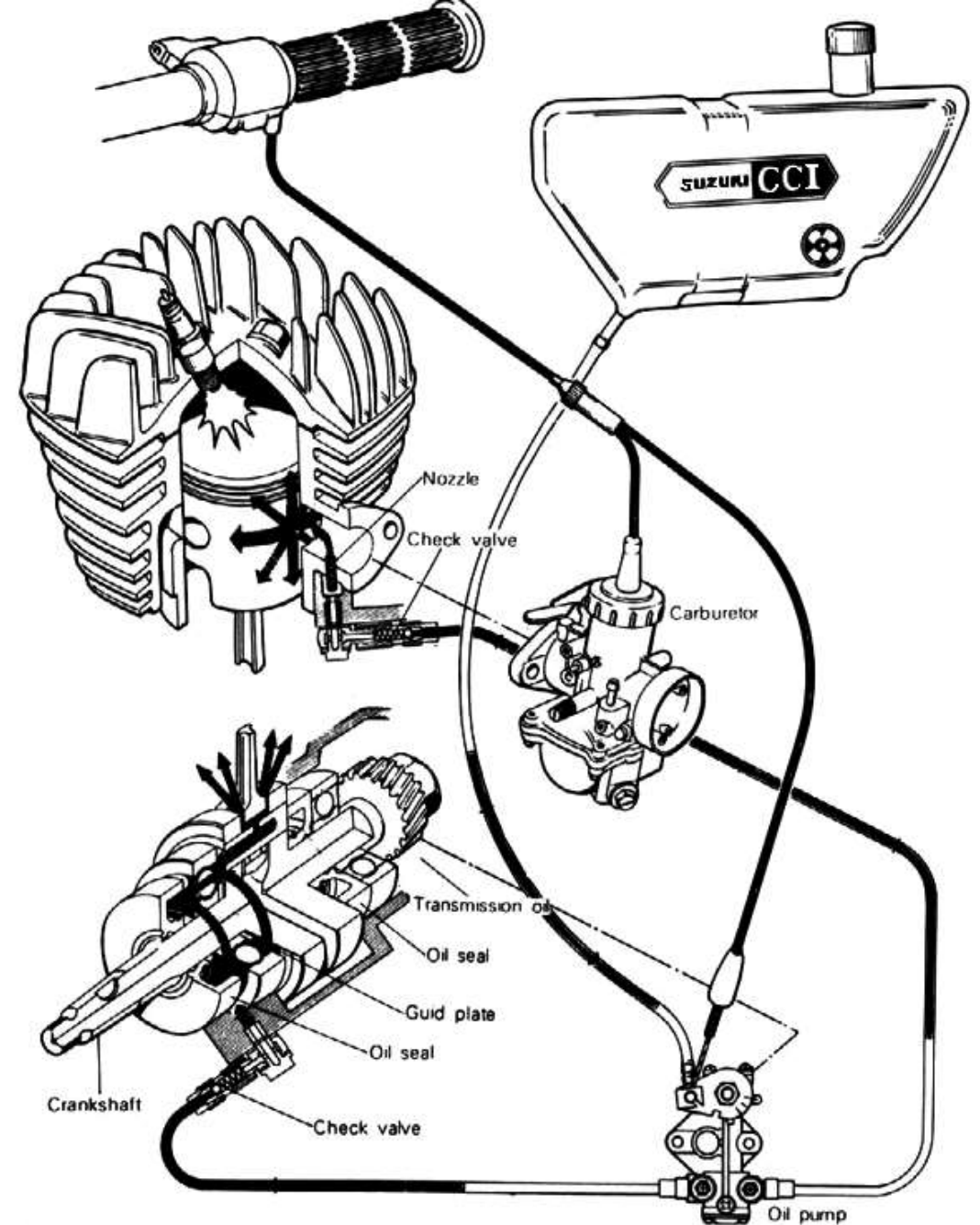
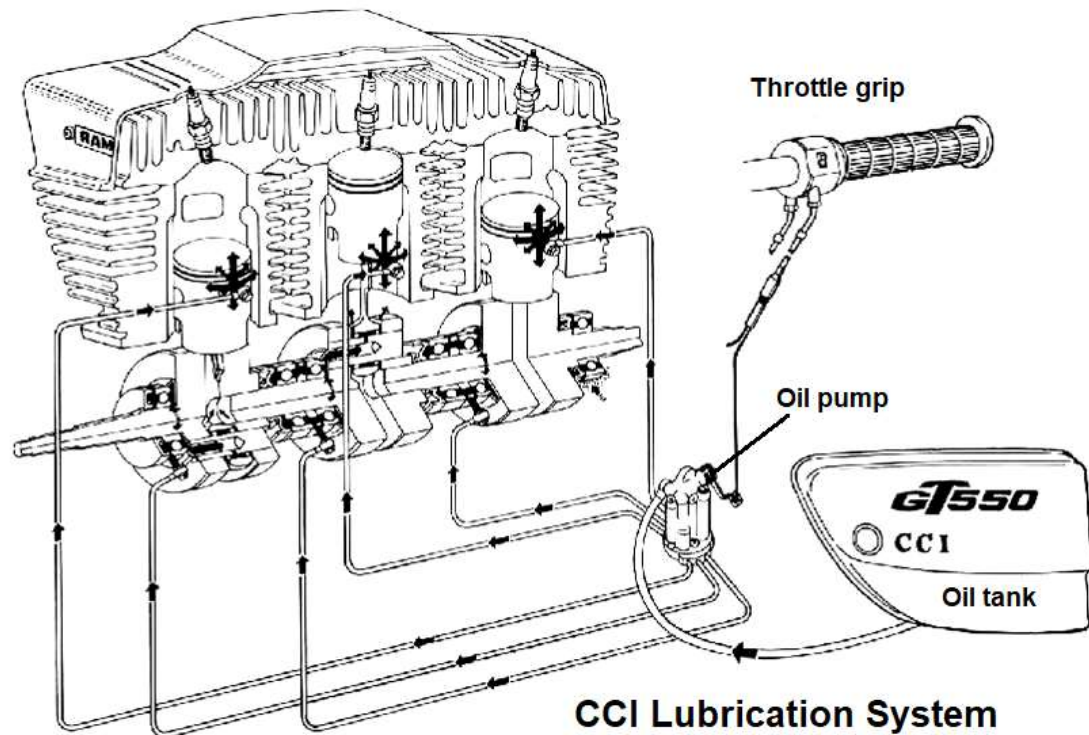
Two Stroke Engine Lubrication

- **Port Injection System** This system lubricate by pumping the oil into the intake port just down the stream from the carburetor. And the amount of oil pumped is controlled by the rpm and the throttle body settings



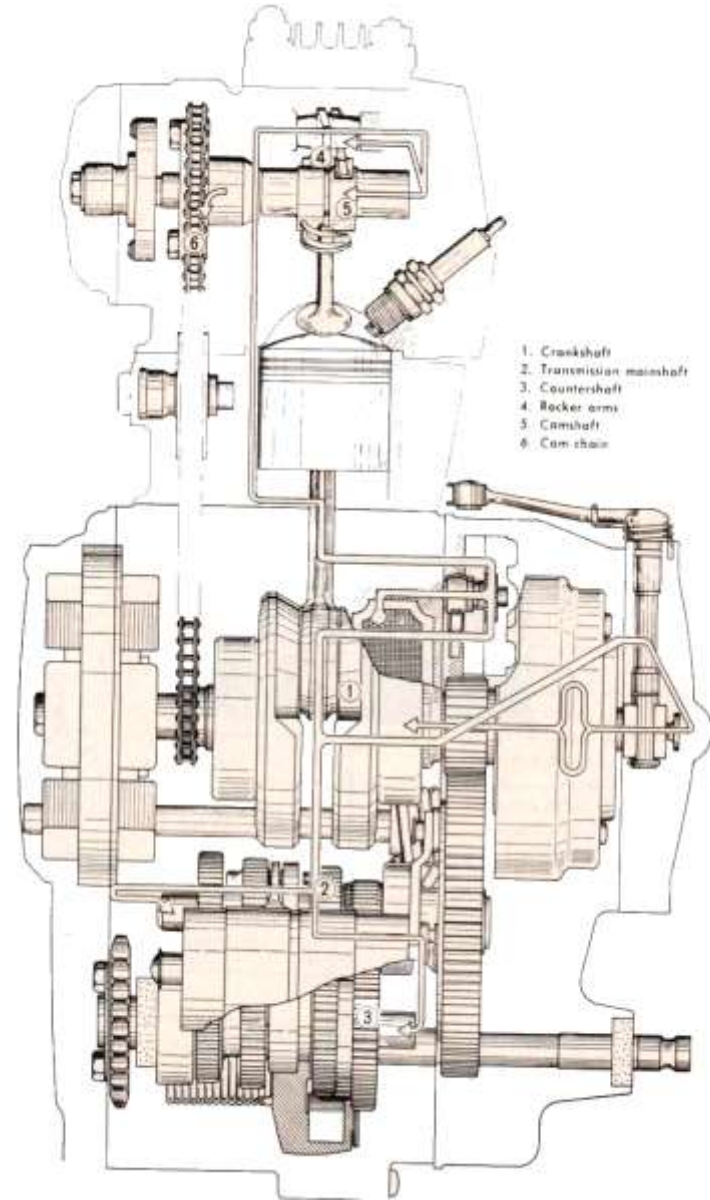


- C.C.I Direct bearing Lubrication**
 This System developed by Suzuki motor, The Cylinder Crank Injection (CCI) system, which reduces oil consumption and achieves excellent durability. This system supplies the required amount of oil under pressure directly to the required points

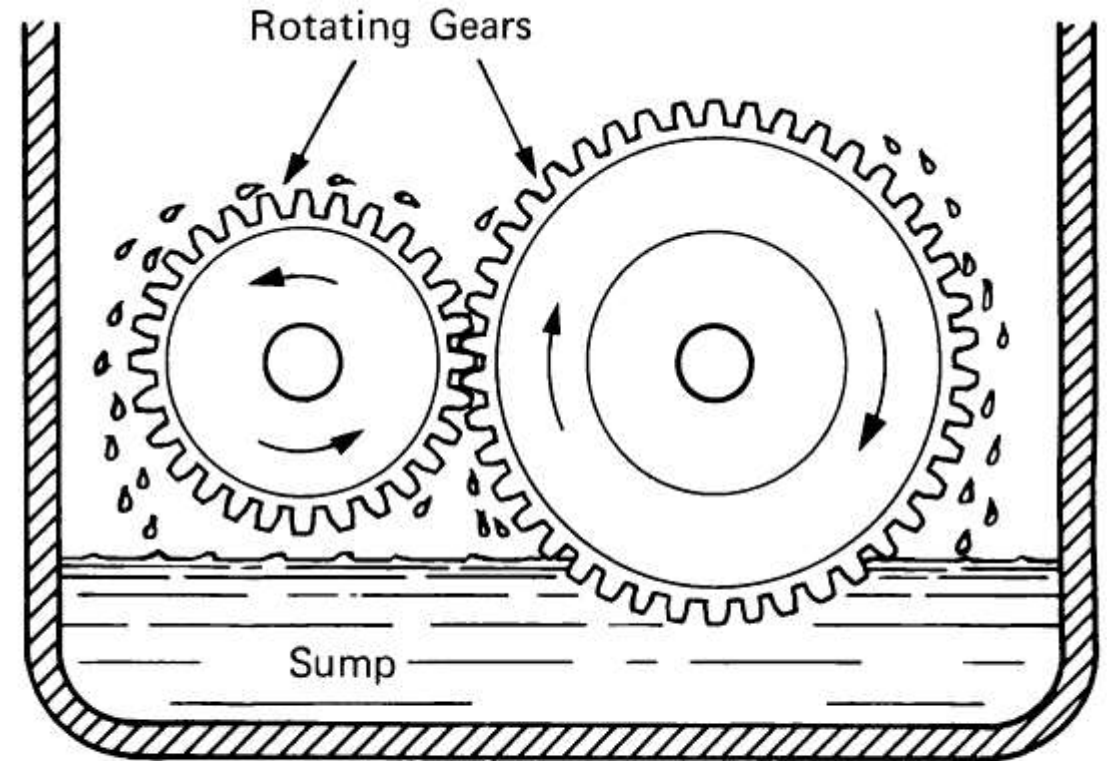


Four Stroke Lubrication Systems

- There are Two major methods of Lubrication in a four stroke motorcycle engines and they are the **Wet-sump** lubrication and this system is widely used. And **dry sump** lubrication system

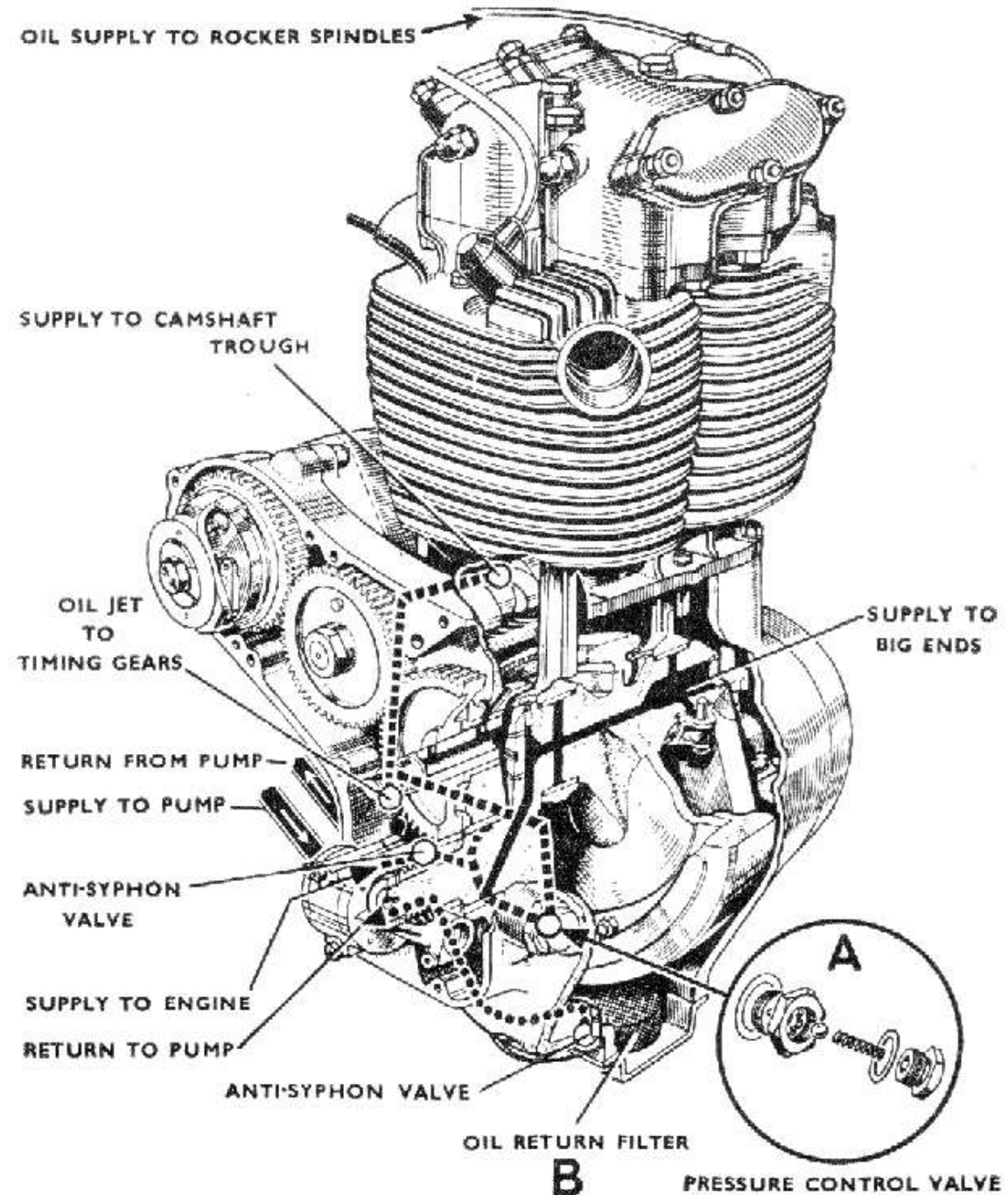


- **Wet sump** In this system, oil is supplied from the sump strainer to various parts of the engine. After completing its lubrication process, the oil then returns to the sump. Since oil is always present in the sump, this lubricating system is known as “wet sump”.

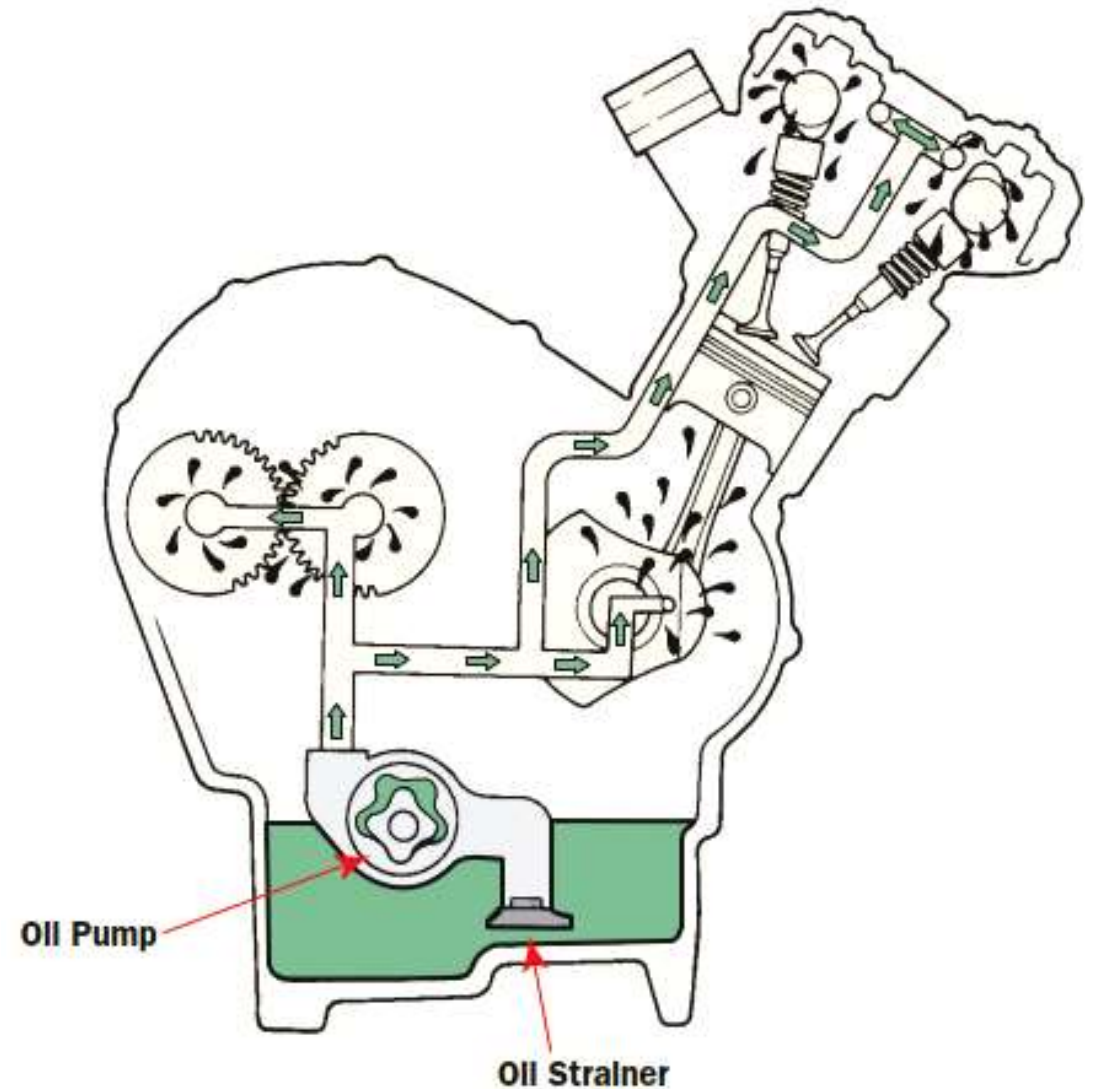


Gear lubrication, showing how gears pick up oil from the sump as they rotate

Wet sump Lubrication system

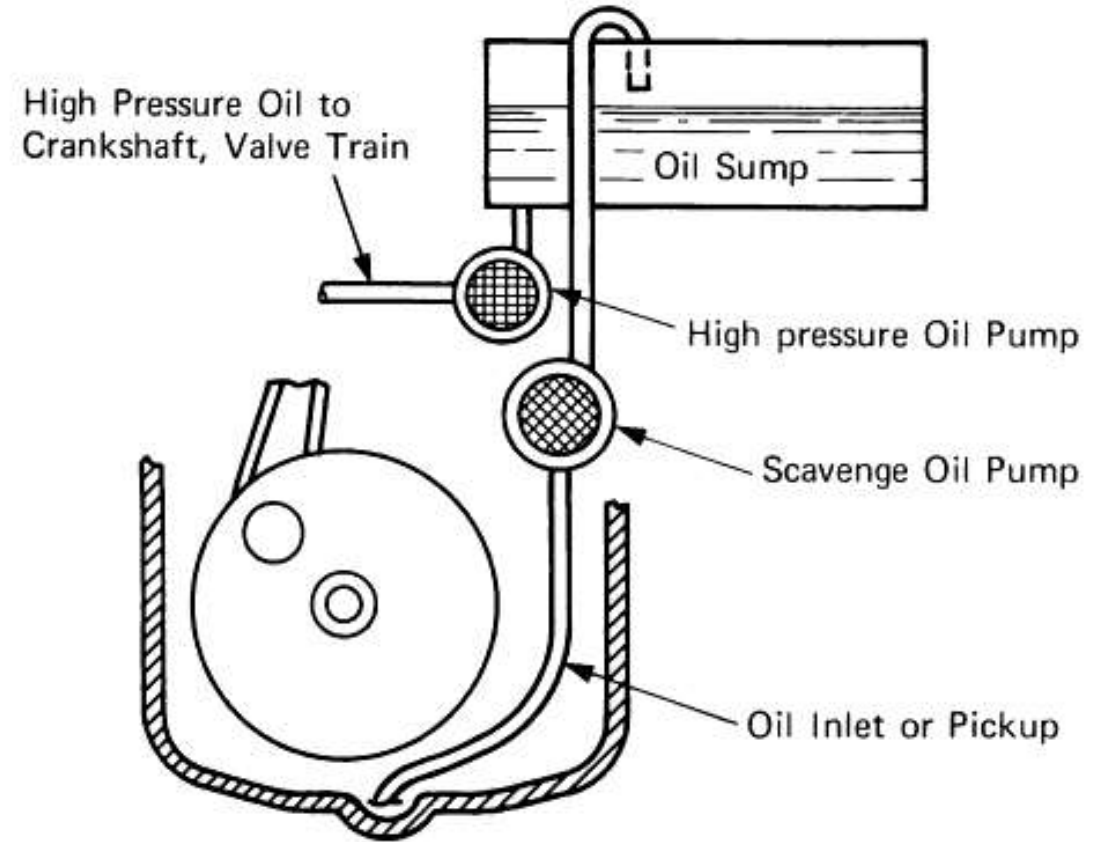


- **Wet sump** systems use the engine to contain the oil. This eliminates the need for an external oil tank and the attendant, leak prone lines that go with it. On the downside it creates a taller engine and may lead to higher oil temperatures. Which in turn, may create the need for an oil cooler with external lines that may leak!



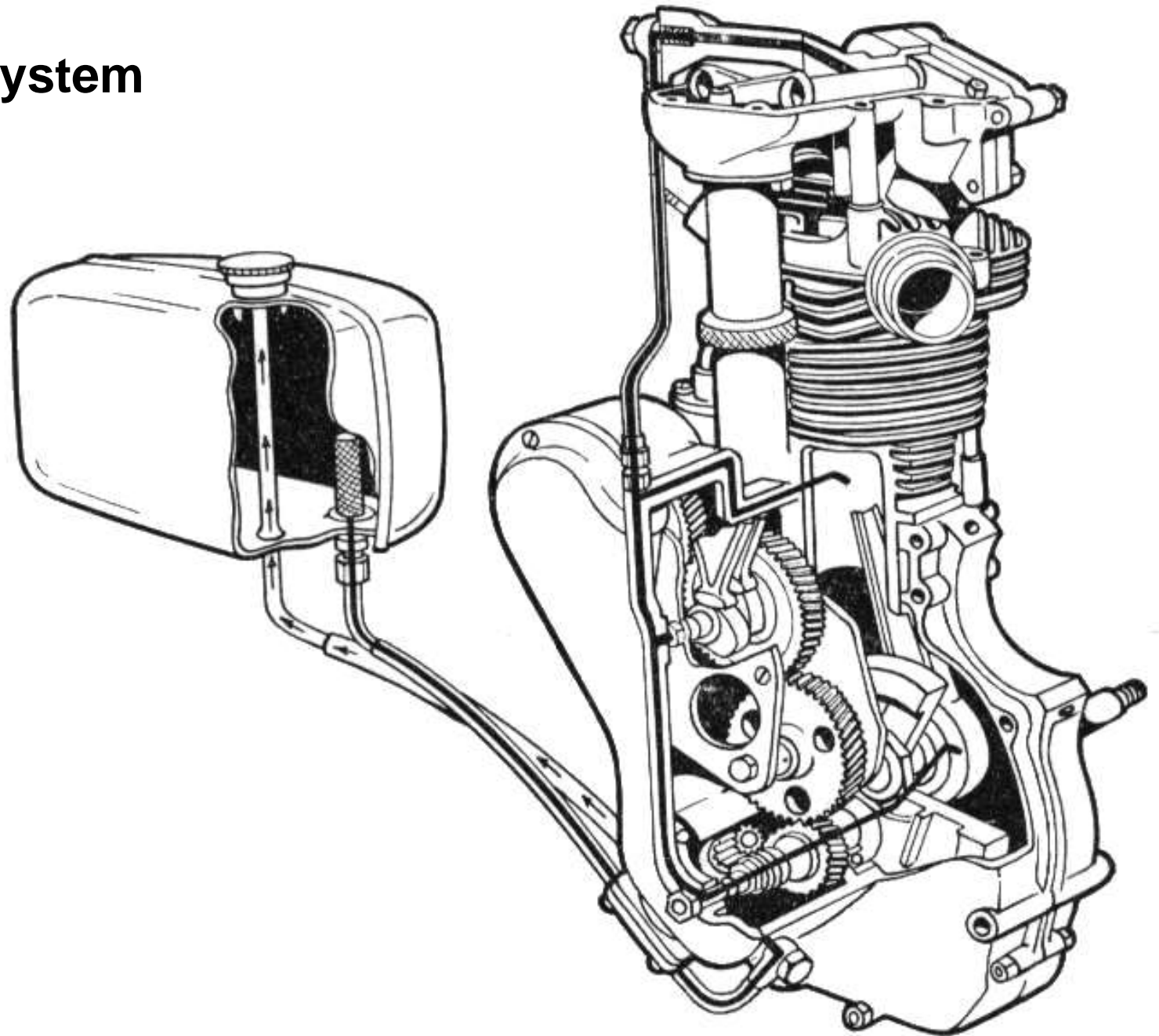
Wet sump

- **Dry sump** In dry sump lubrication, the lubricant is stored in a special tank. From there, the oil reaches the lubrication points via a pump. The oil drips off the lubrication points and forms an oil sump.

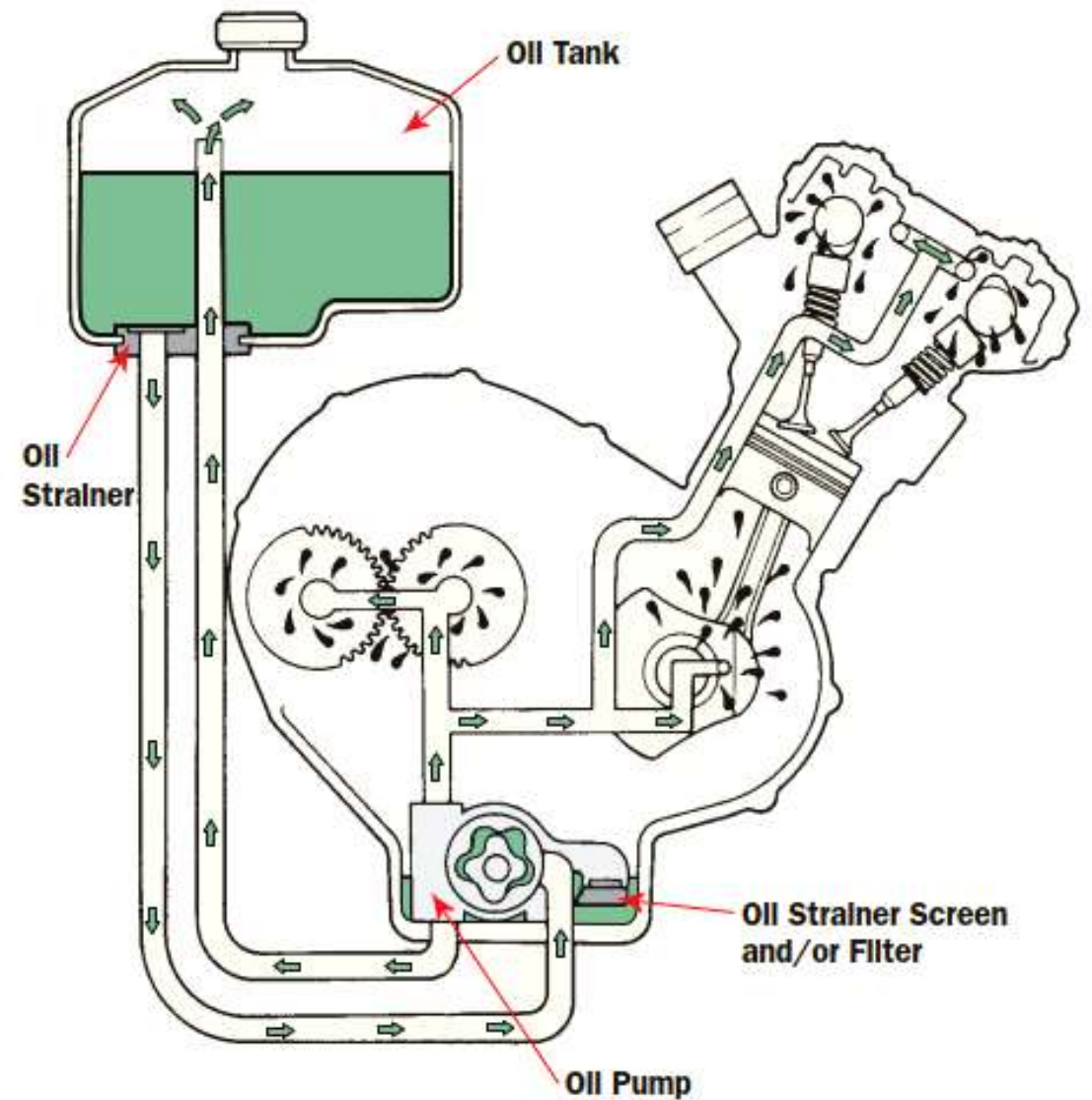


Dry sump oil system

Dry sump Lubrication system

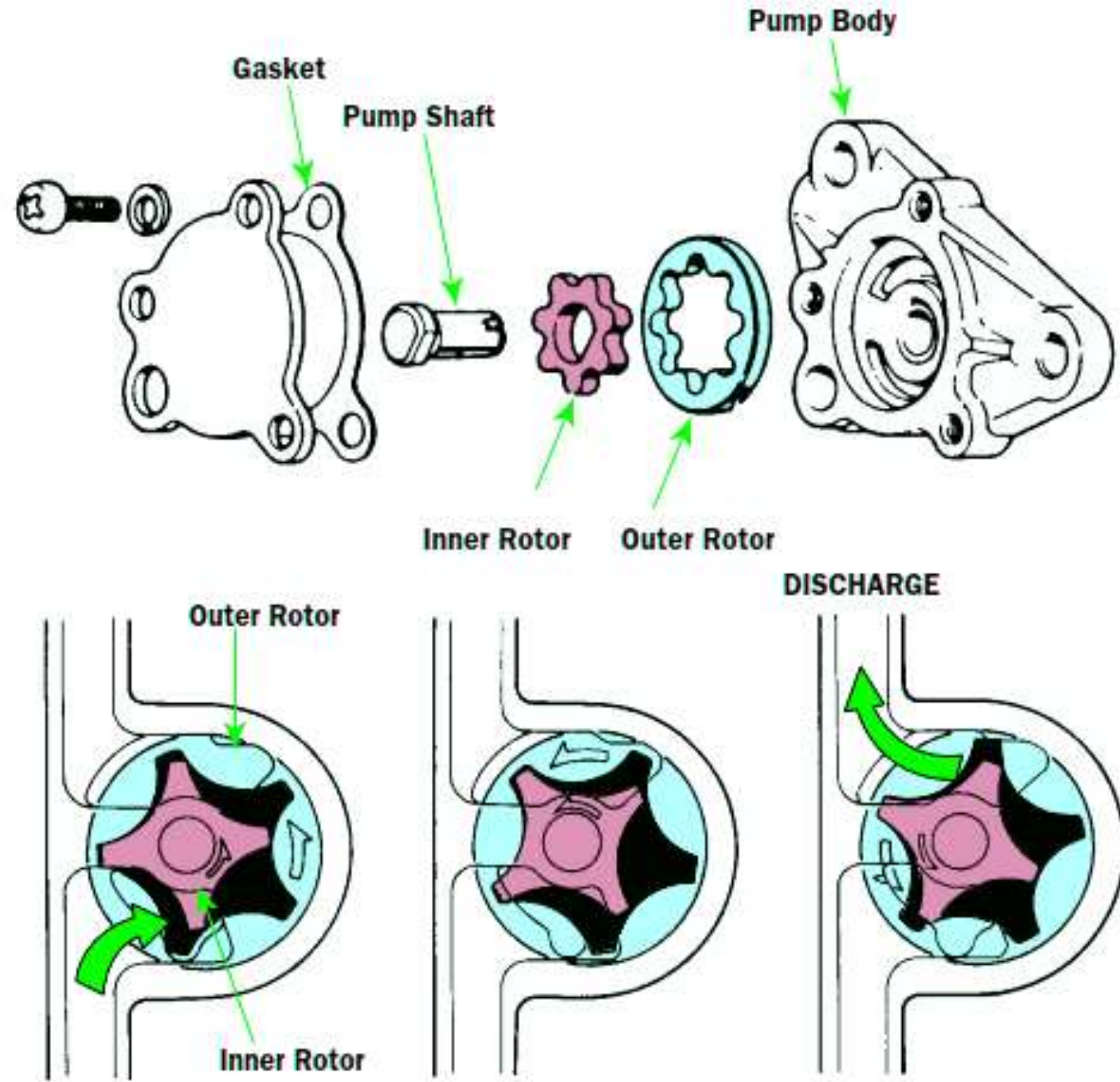


- **Dry-sump** systems use an external oil tank and dual-function oil pumps. In this system, the pump draws in oil for delivery to the various components and pumps oil out of the sump and back to the oil tank. Since this design eliminates the need for space to contain the oil within the lower portion of the crankcases, the engine can be positioned lower than would otherwise be possible. This design often incorporates routing and oil storage configurations that aid in lowering oil temperature.



Dry-sump

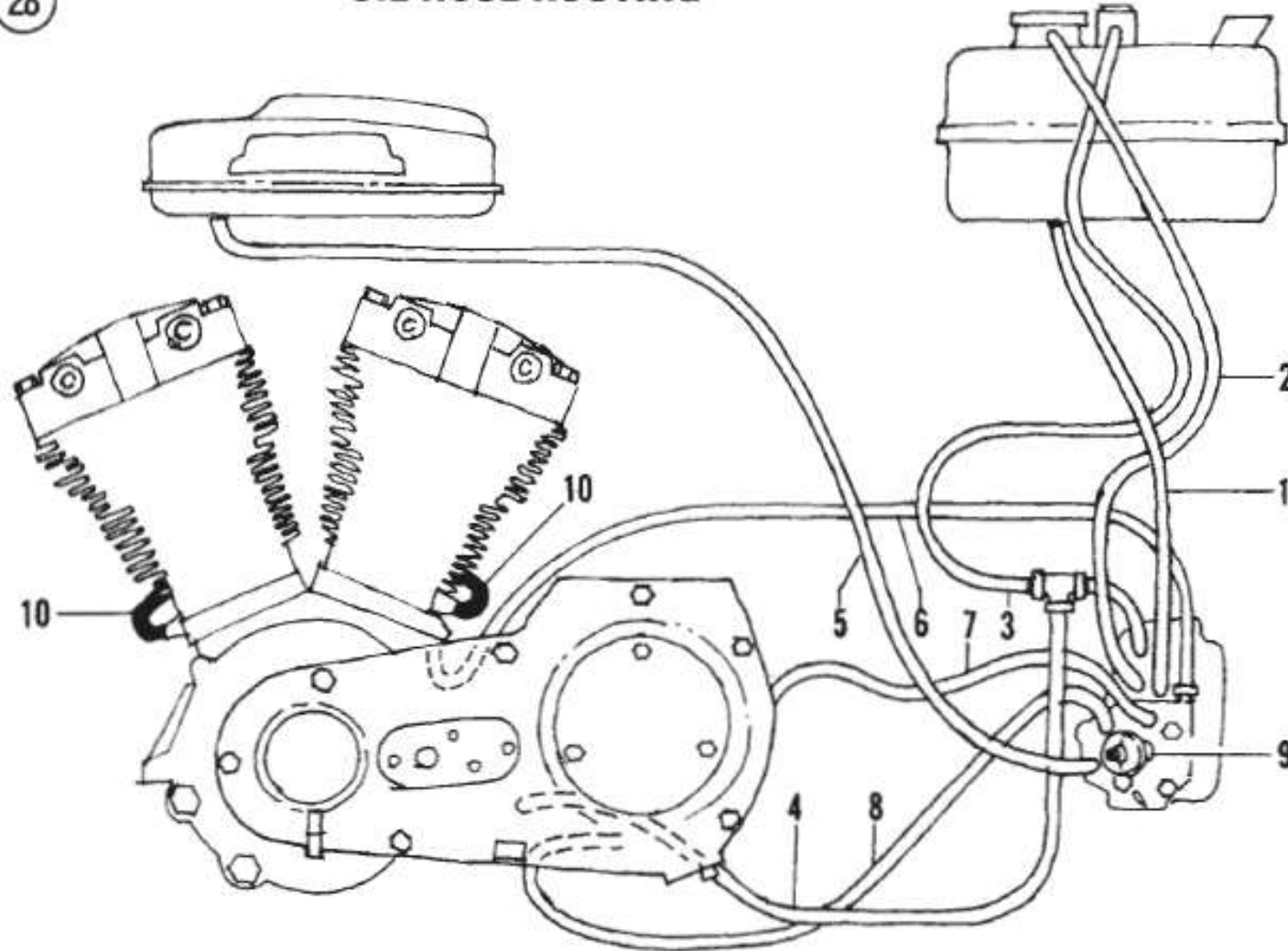
- **Trochoid pump** has an inner rotor and outer rotor coming into contact each other and create gap in between. As the pump rotates, the volume of the gap expands and shrinks continuously. Expansion of the gap creates vacuum and fluid is drawn into the pump and as the gap shrinks, compression occurs and fluid is pumped out



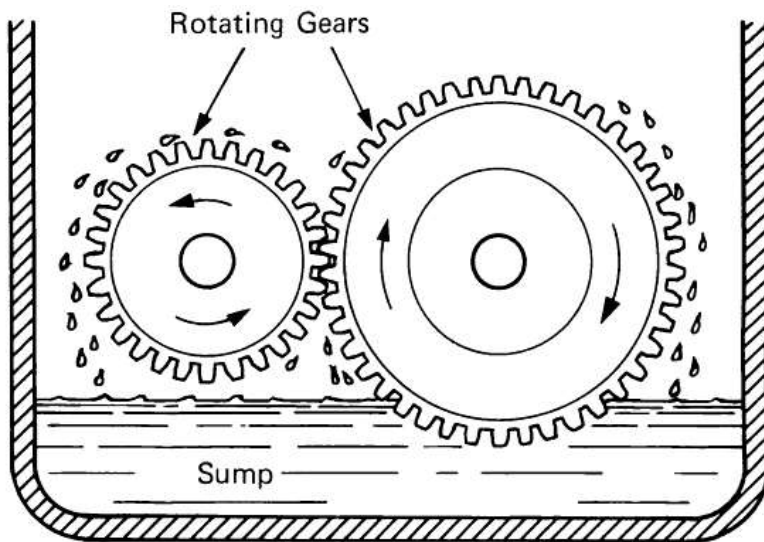
- **Primary Case Lubrication**

28

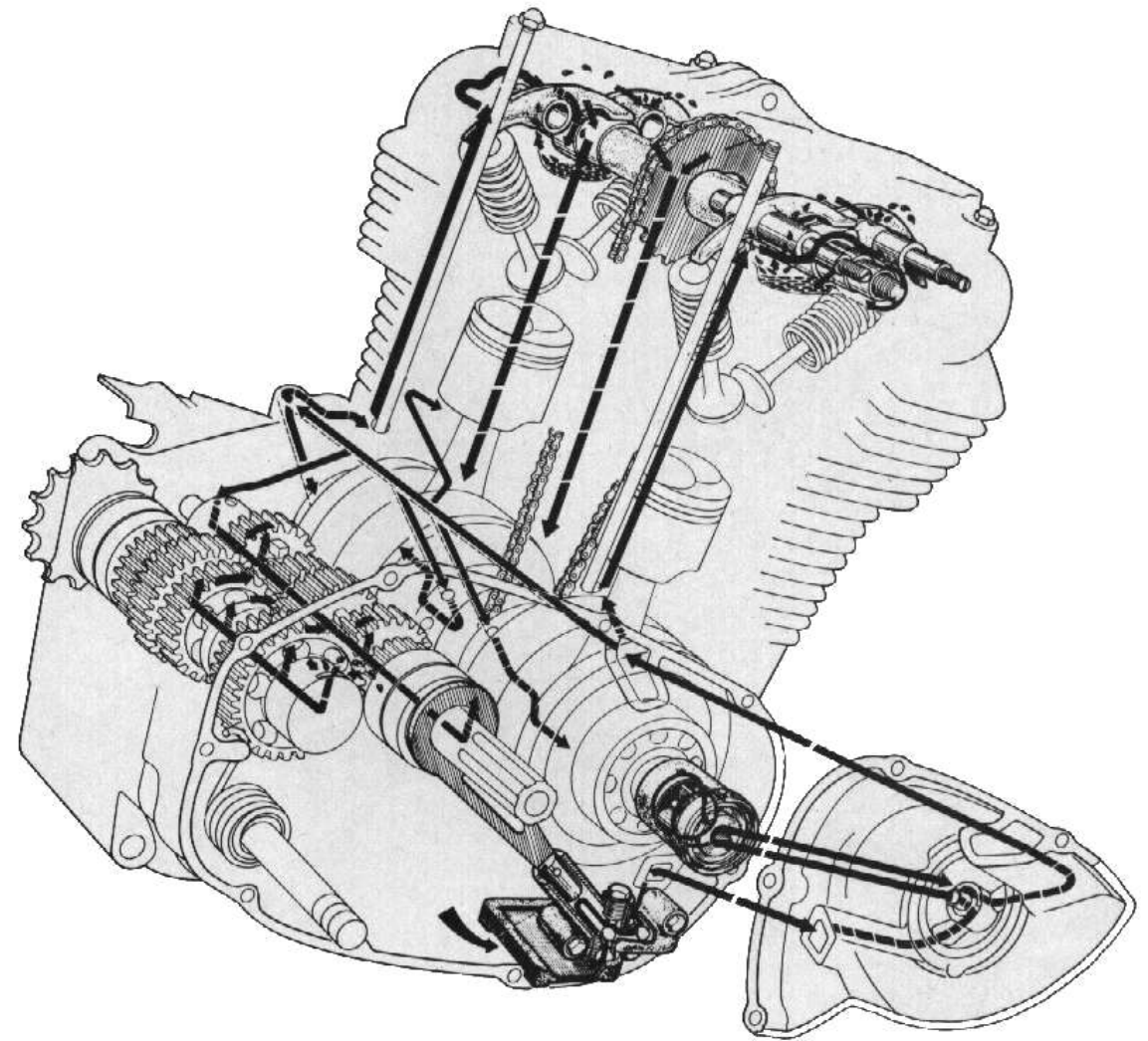
OIL HOSE ROUTING



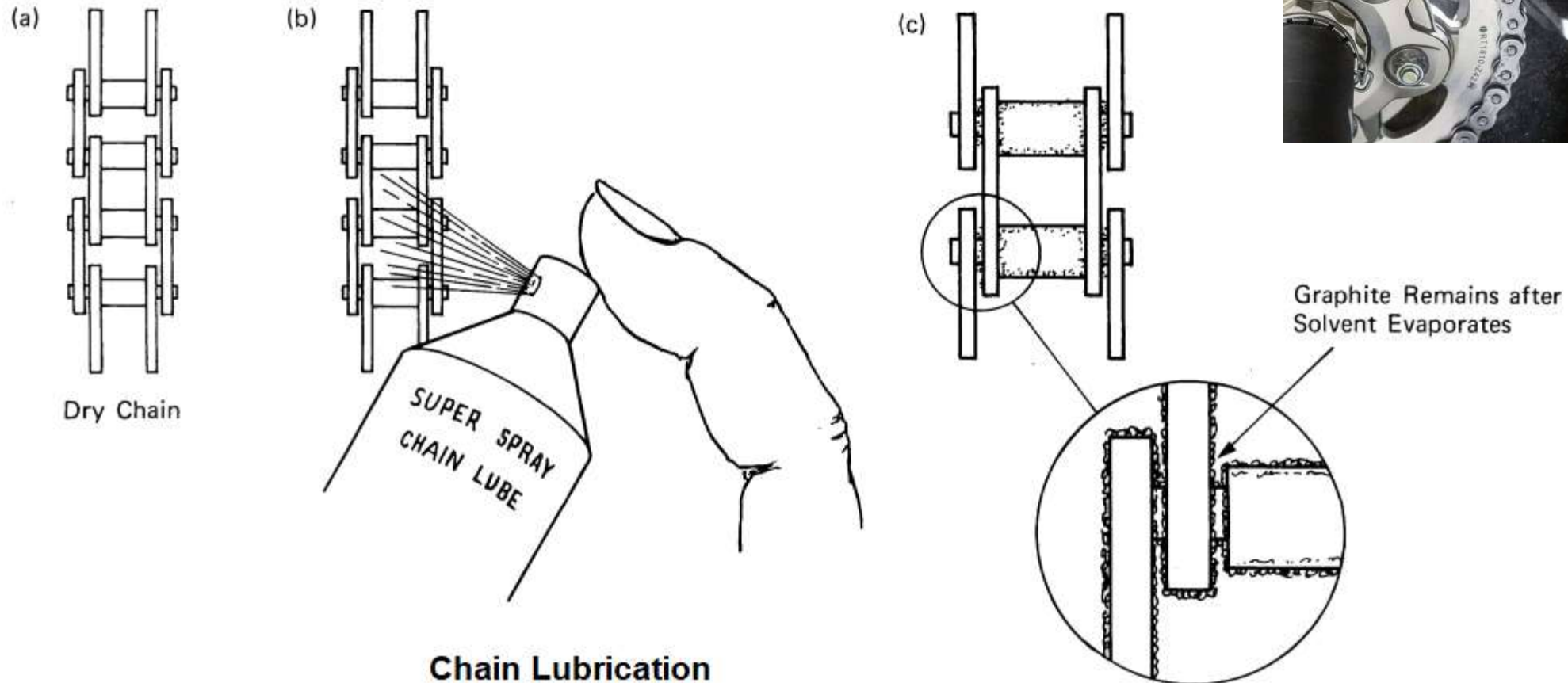
- **Transmission lubrication** Motorcycle **Gear Oil** is a lubricant made specifically for motorbike gear boxes. It is of a high viscosity and usually contains organosulfur compounds. A bike's gearbox oil is vital in keeping your transmission running smoothly and ensuring gears and other internal components are protected against wear and over heating.



Gear lubrication, showing how gears pick up oil from the sump as they rotate



- **Chain Lubrication** Chain lubrication is needed mainly to slow the wear between the pins and bushings in the chain joints, to flush out wear debris and foreign materials, and to smooth the chain's engagement with the sprocket.



- Chassis Lubrication
- Steering Head



Swing arm pivot
lubrication protect the
suspension

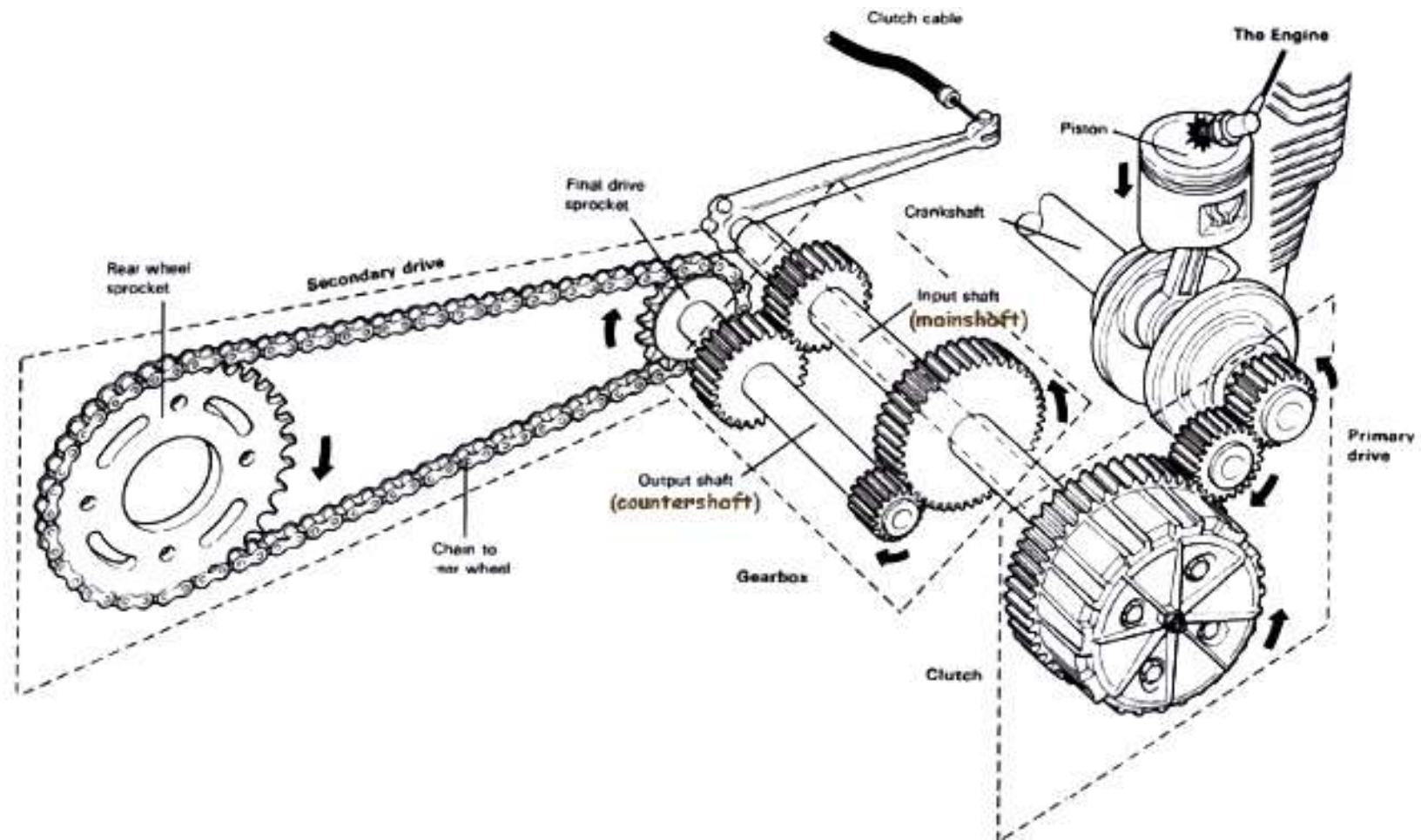


Brake Lever

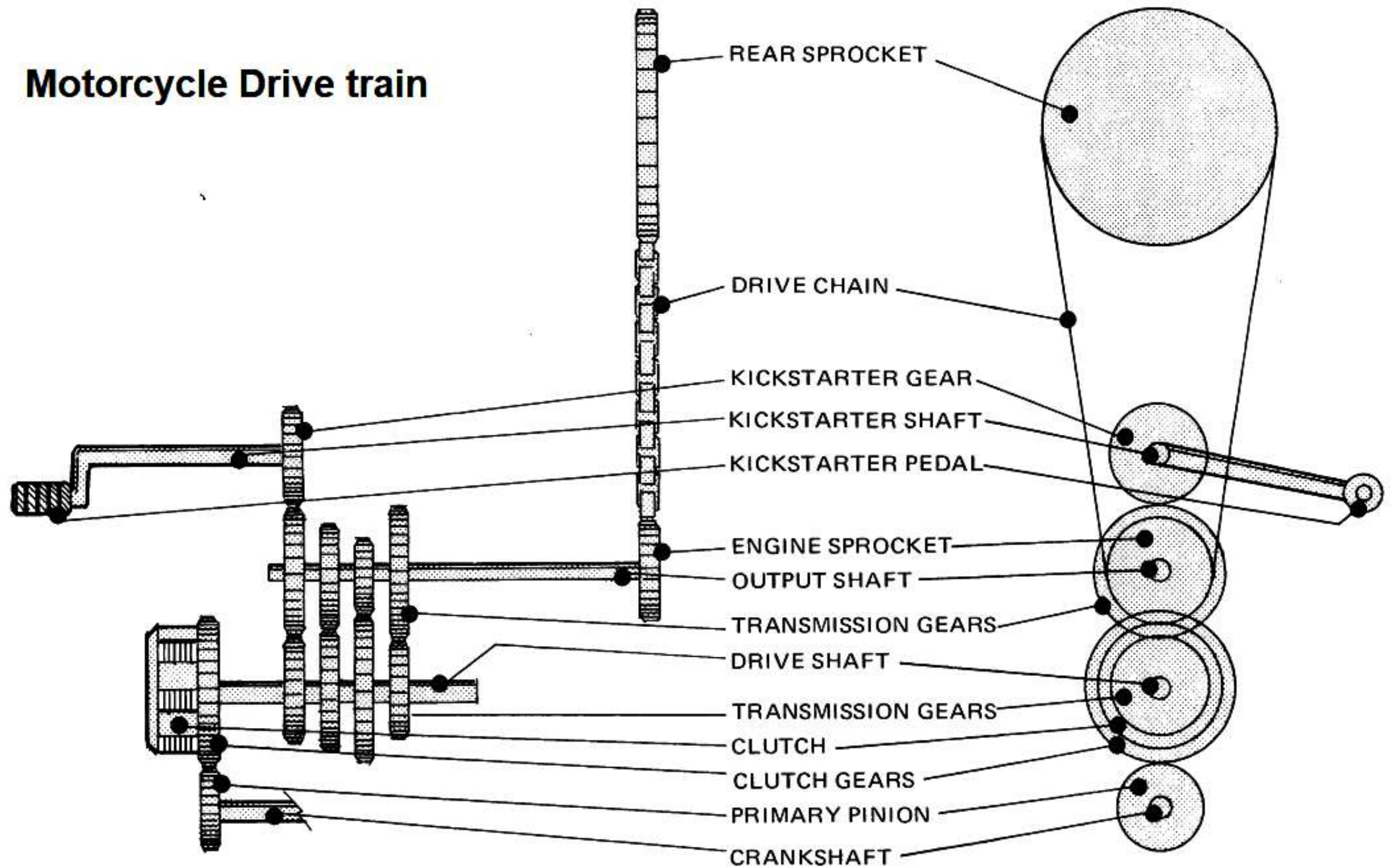


Primary Drive and Clutch

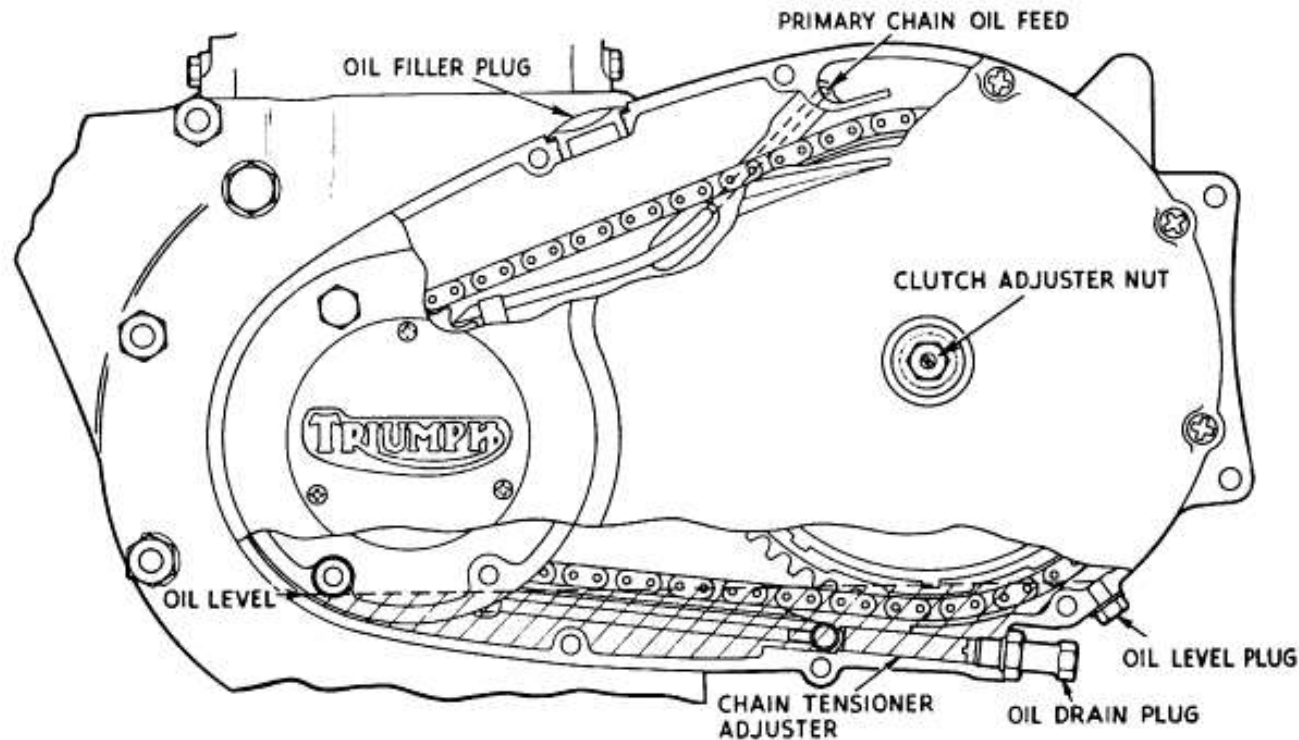
- The primary drive on a motorcycle is the system of gears and chains that transfer power from the engine to the rear wheel.



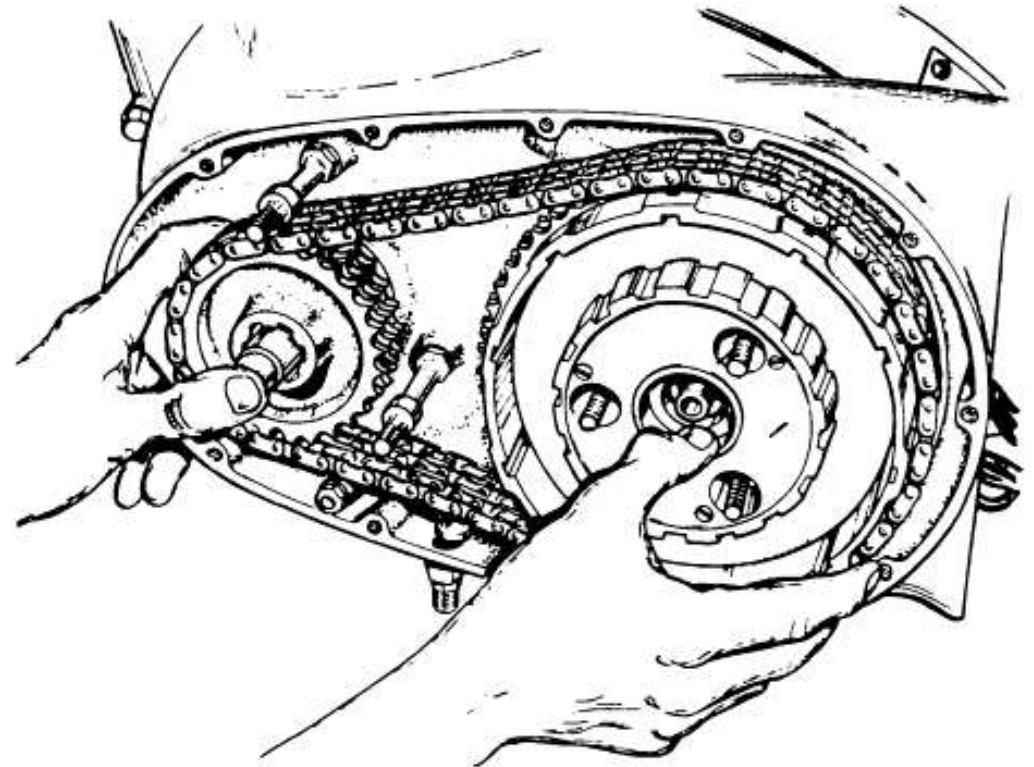
Motorcycle Drive train



- **Primary drives** on motorcycles are of two types - A crankshaft sprocket and a chain from there to the clutch sprocket. This system spins the gearbox in the same direction to the crankshaft. A crank pinion (driving gear) meshing with the gear on the gearbox input shaft.



Typical chain drive primary

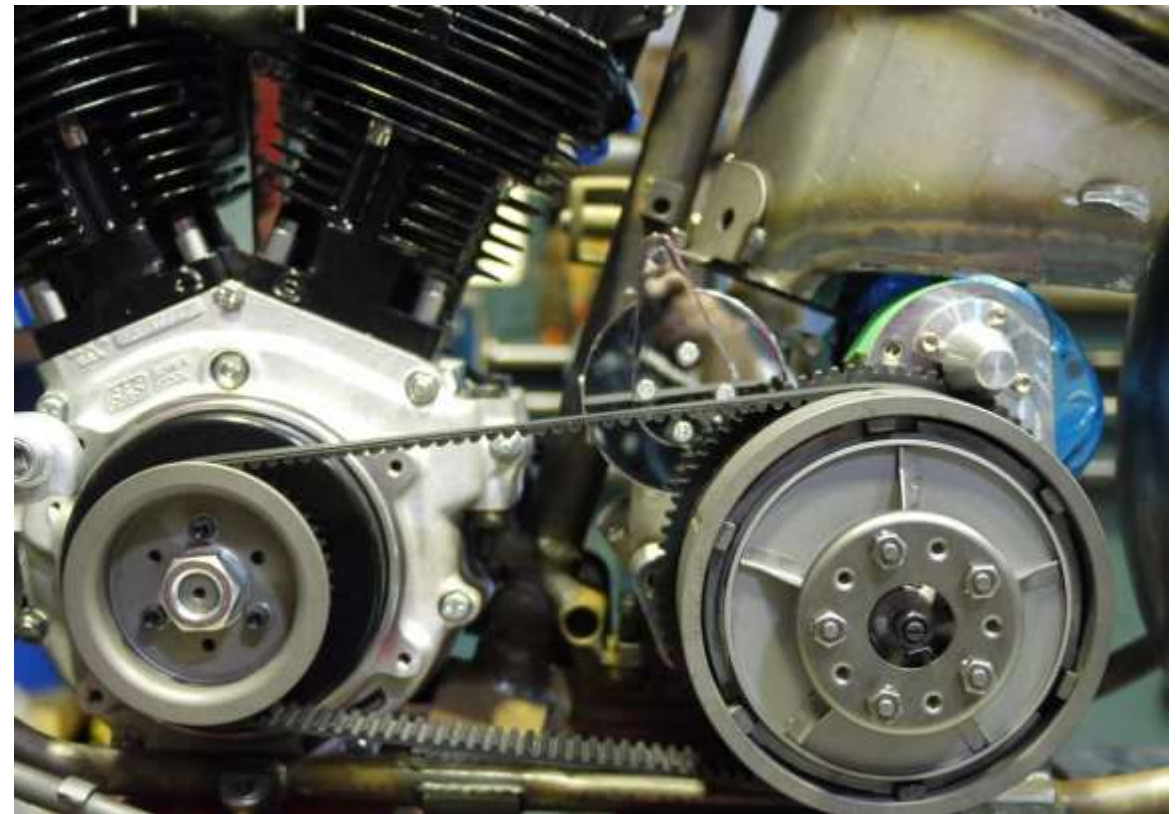


Triple roller chain primary drive

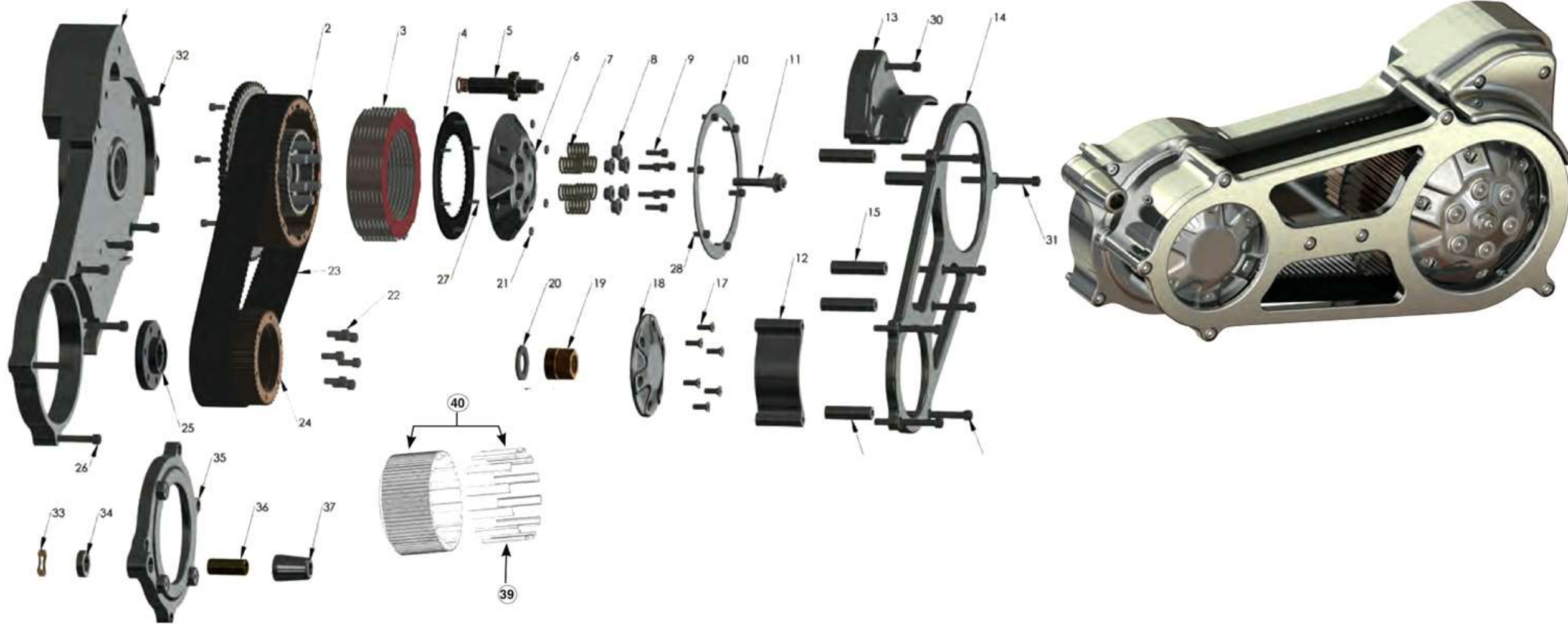
- When the engine is going at full swing, it burns fuel and produces a lot of power. All this power is transmitted to the crankshaft and this in turn moves on to the gearbox to be twerked and sent to the wheels. This entire process of transmitting power to the gearbox and it when eventually makes it to the front cog of the setup is what is Primary Drive.



- Unlike **chain drive**, which requires very frequent cleaning, tightening and maintenance, **belt drives** are relative maintenance free. They run clean as they don't have to be lubricated with sticky lubes and don't require cleaning either. Belt drive systems also run much smoother, with much less jerks as compared to chain drives, and produce incomparably less noise too

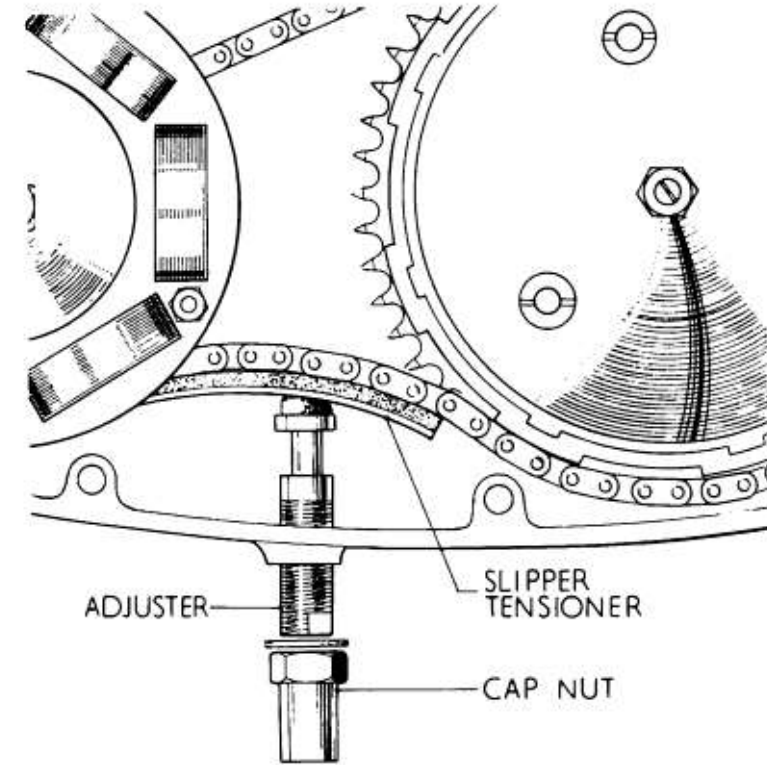


PRIMARY BELT DRIVE





Primary chain adjuster



Gears

- Primary gears are the gear on the end of the shaft drive by the clutch and the gear that it drives.
- On some motorcycle the primary drive is set of two gears, A small gear on the end of the crankshaft. And a large gear on the clutch.



Helical gear



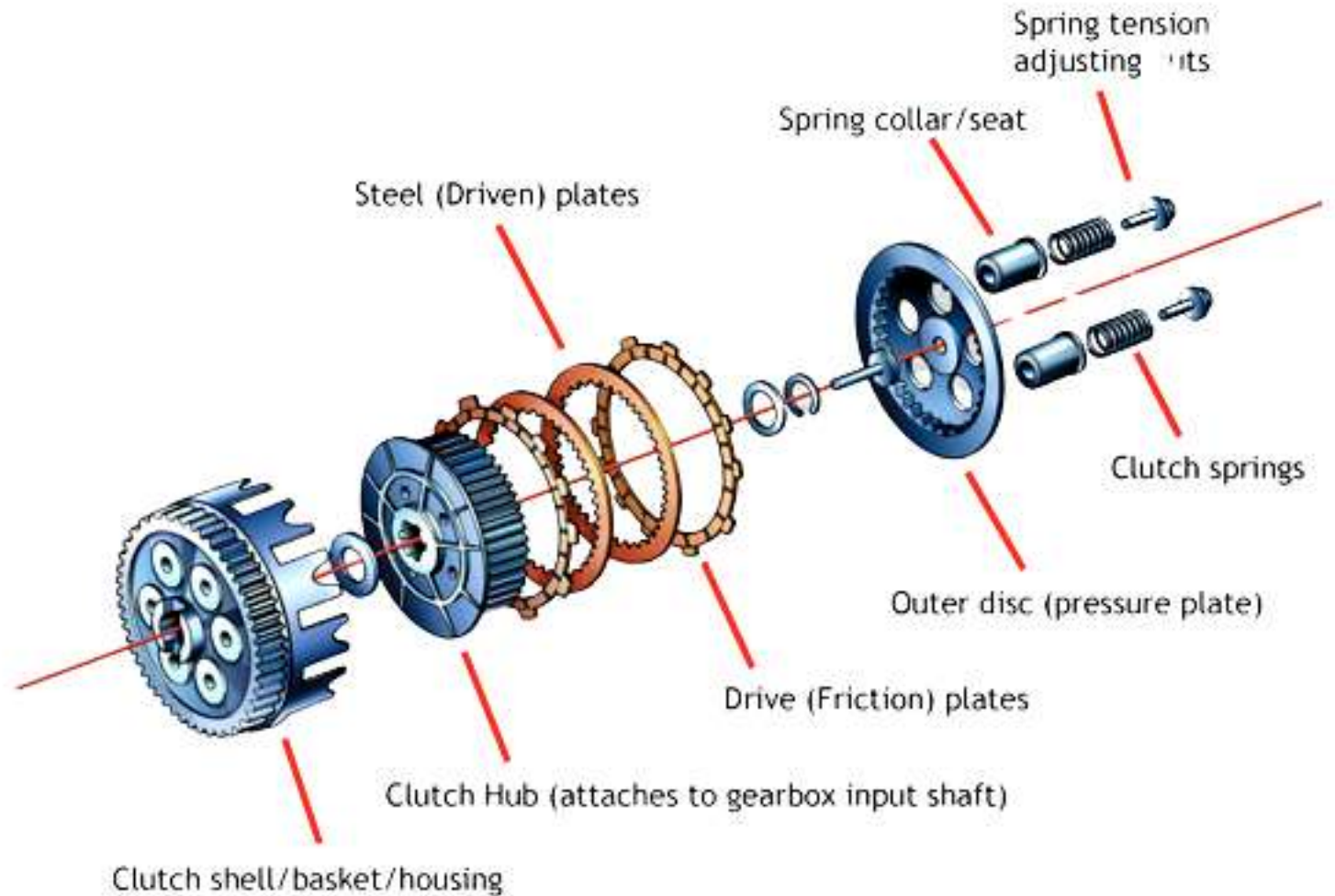
Straight gear

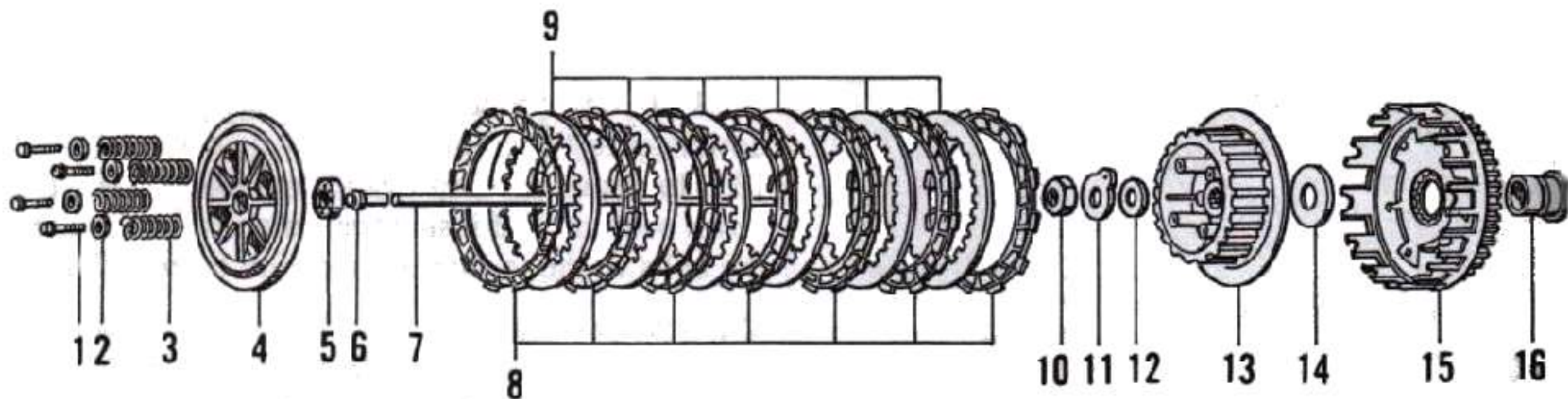
- The straight cut primary gears have several advantages over the helical cut originals. They consume less horsepower and reduce side thrust on crankshaft and gear box shafts. Straight cut primary gears are used in most modern performance motorcycles.



Clutch

- the clutch is the component in the engine that engages and disengages power from the engine to the transmission in order to change gears. In other words, it enables the rider to turn on or off power to the rear wheel to change gears.



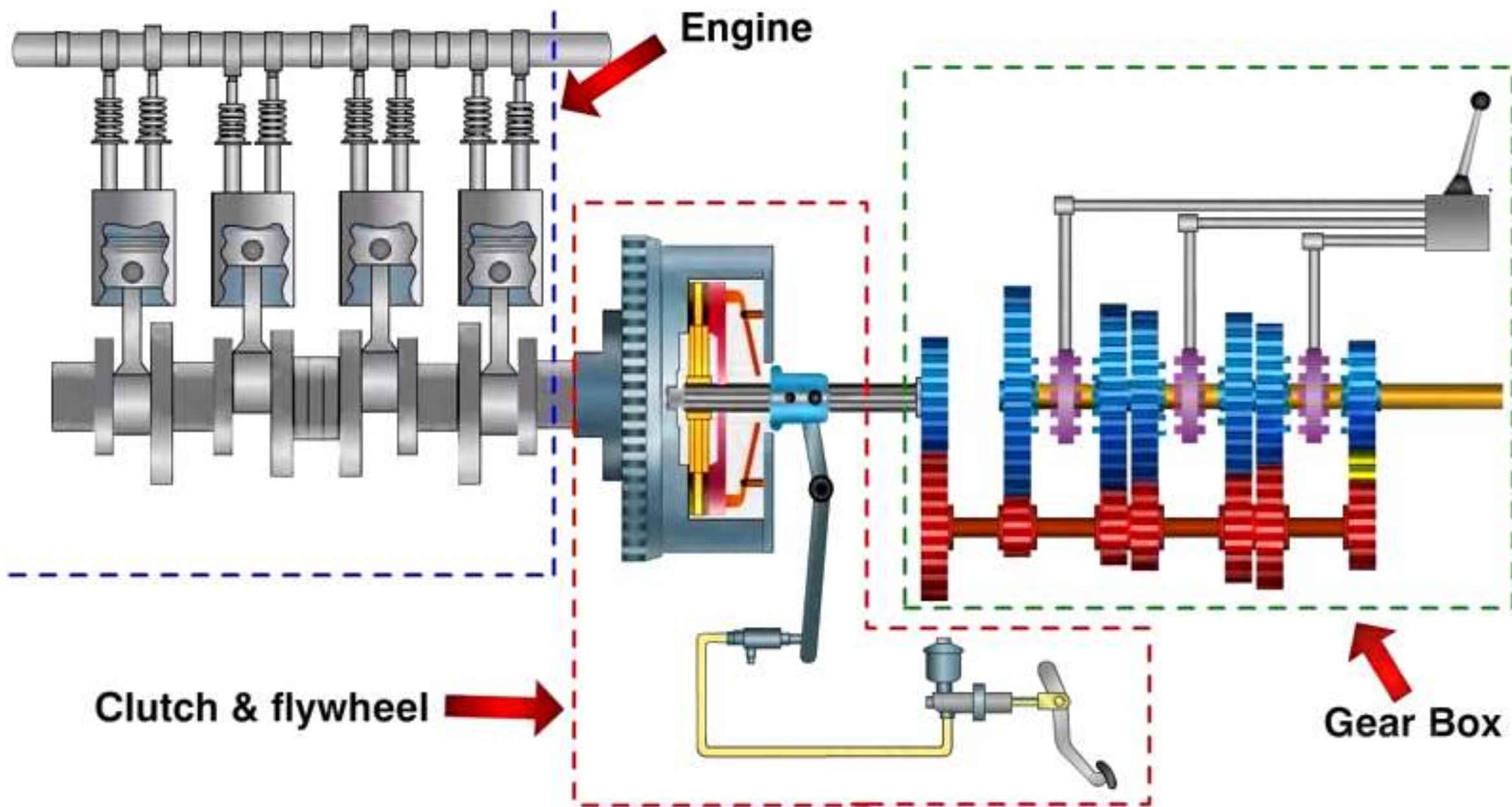


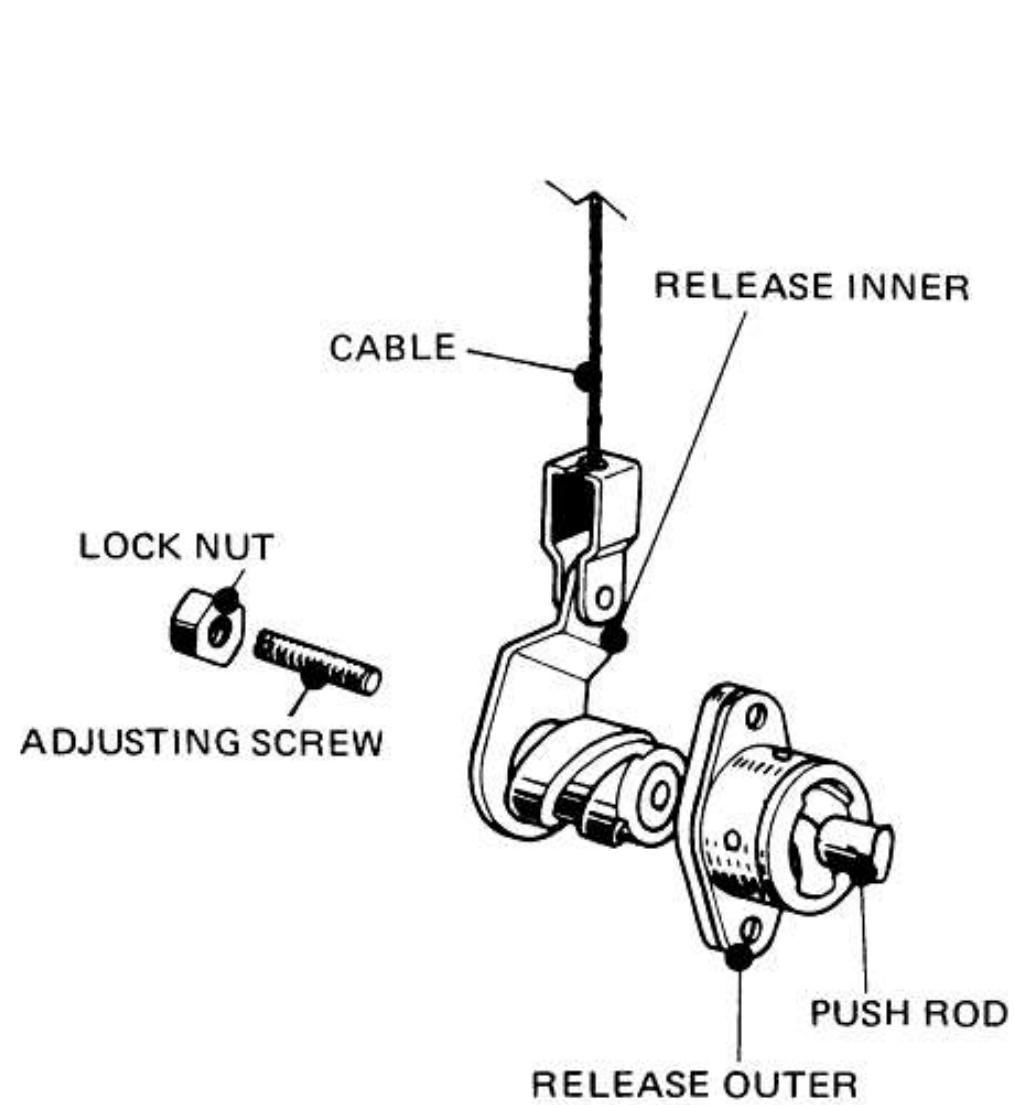
1. Clutch bolts
2. Washer
3. Clutch springs
4. Pressure plate

5. Bearing
6. Pushrod tip
7. Pushrod
8. Friction plates

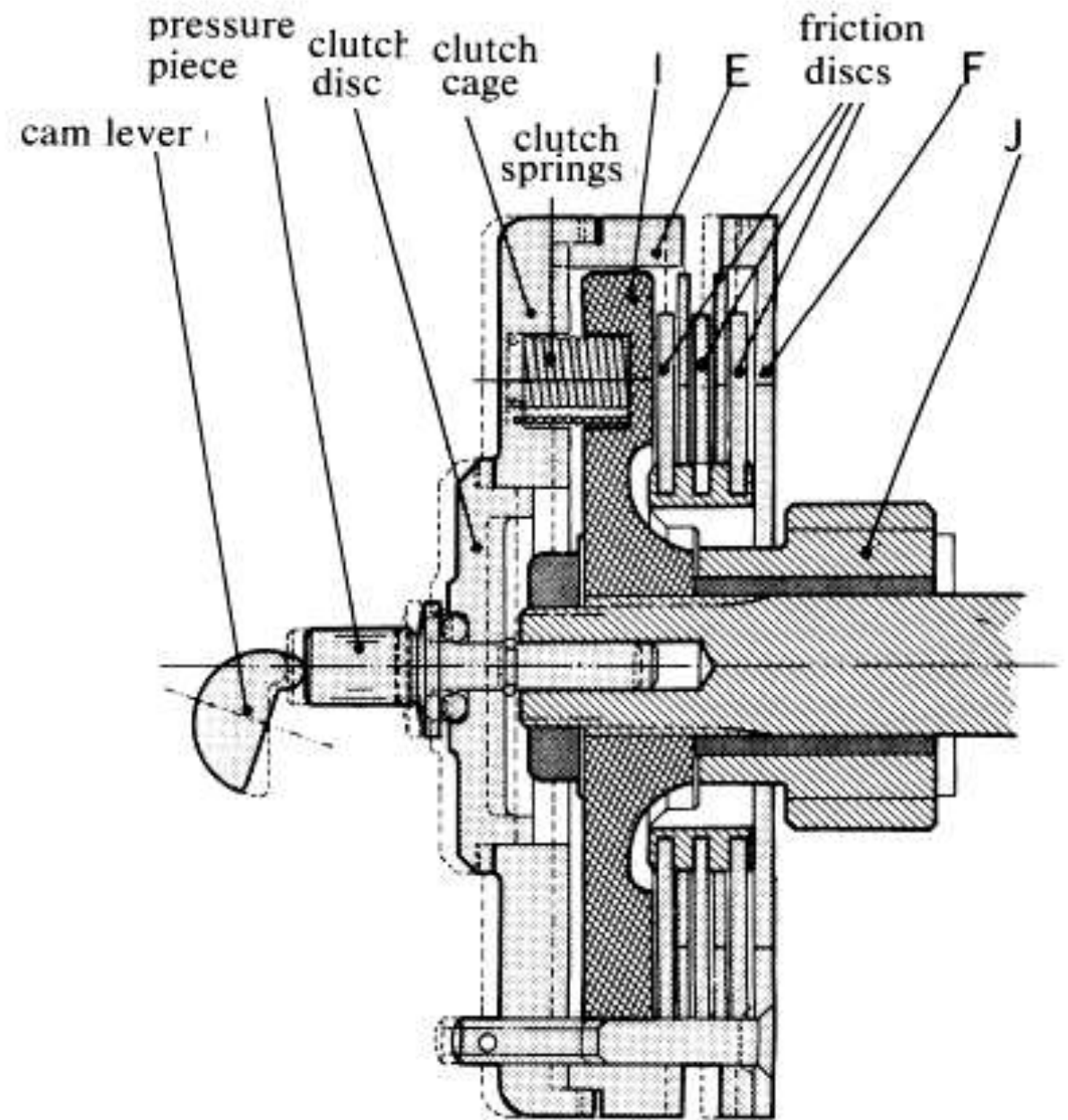
9. Clutch discs
10. Clutch locknut
11. Lockwasher (1986-on 600 cc only)
12. Washer (1986-on 600 cc only)
Lockwasher (all other models)

13. Clutch center
14. Thrust washer
15. Clutch outer housing
16. Clutch outer housing guide





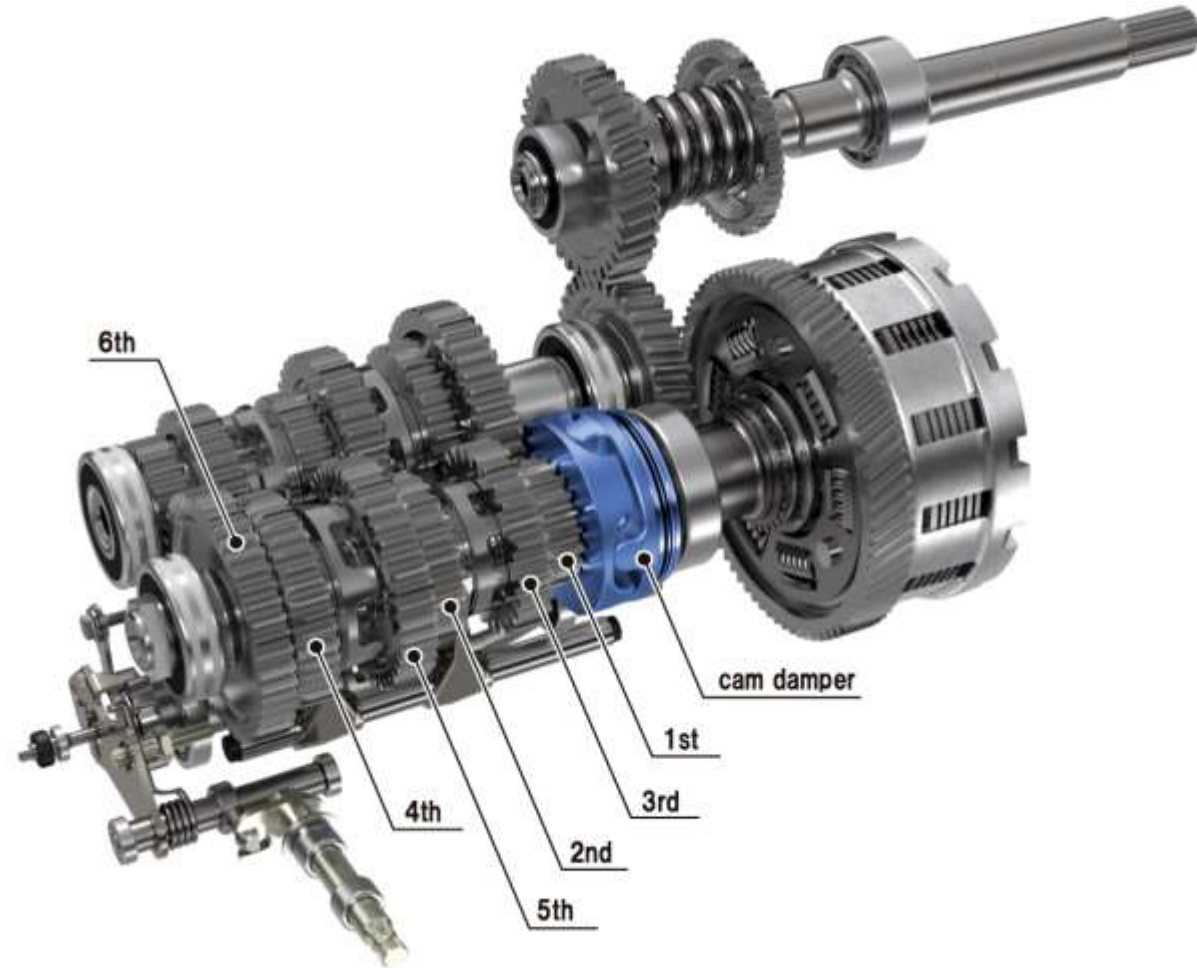
screw type clutch release mechanism



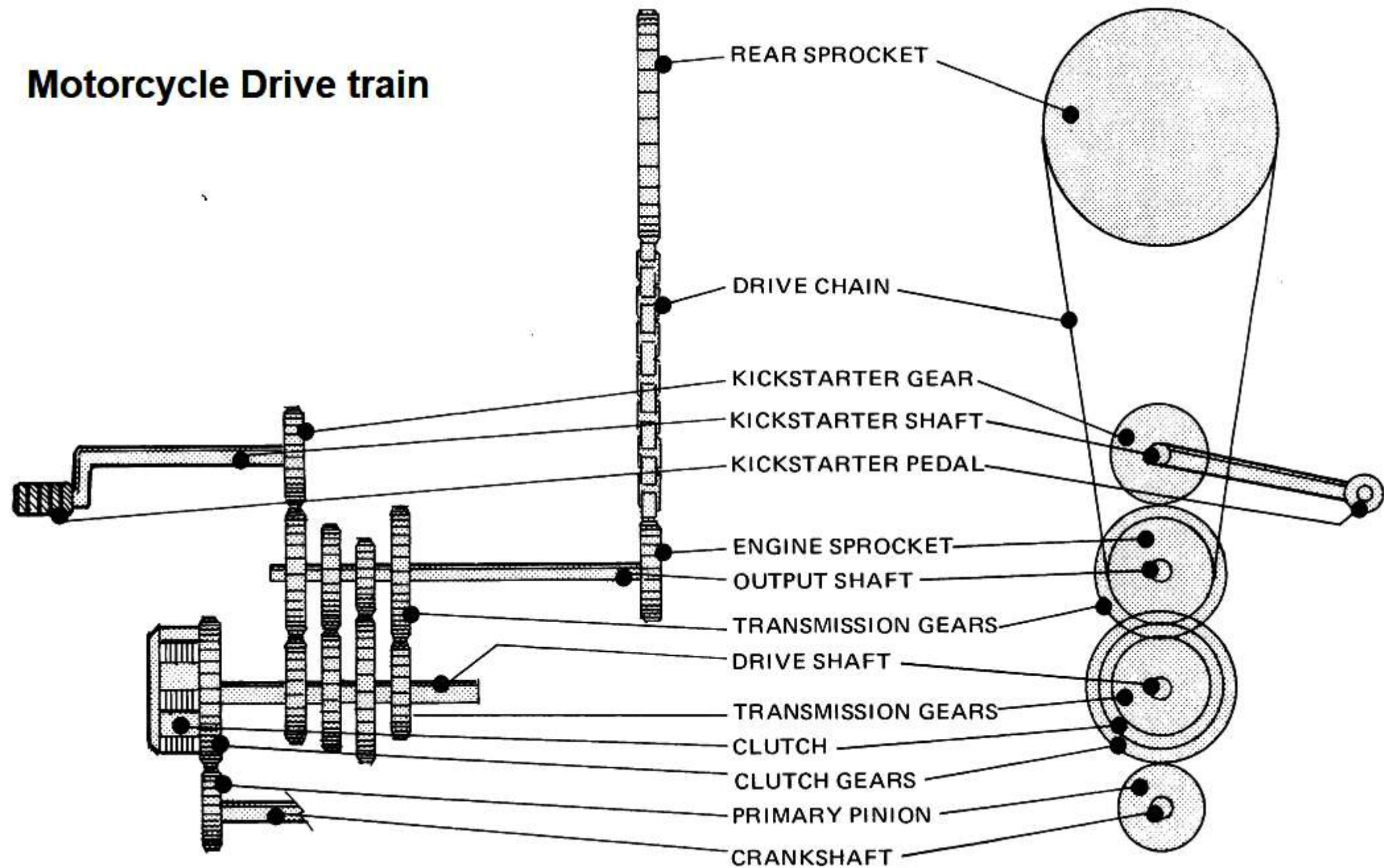
Cam Type clutch

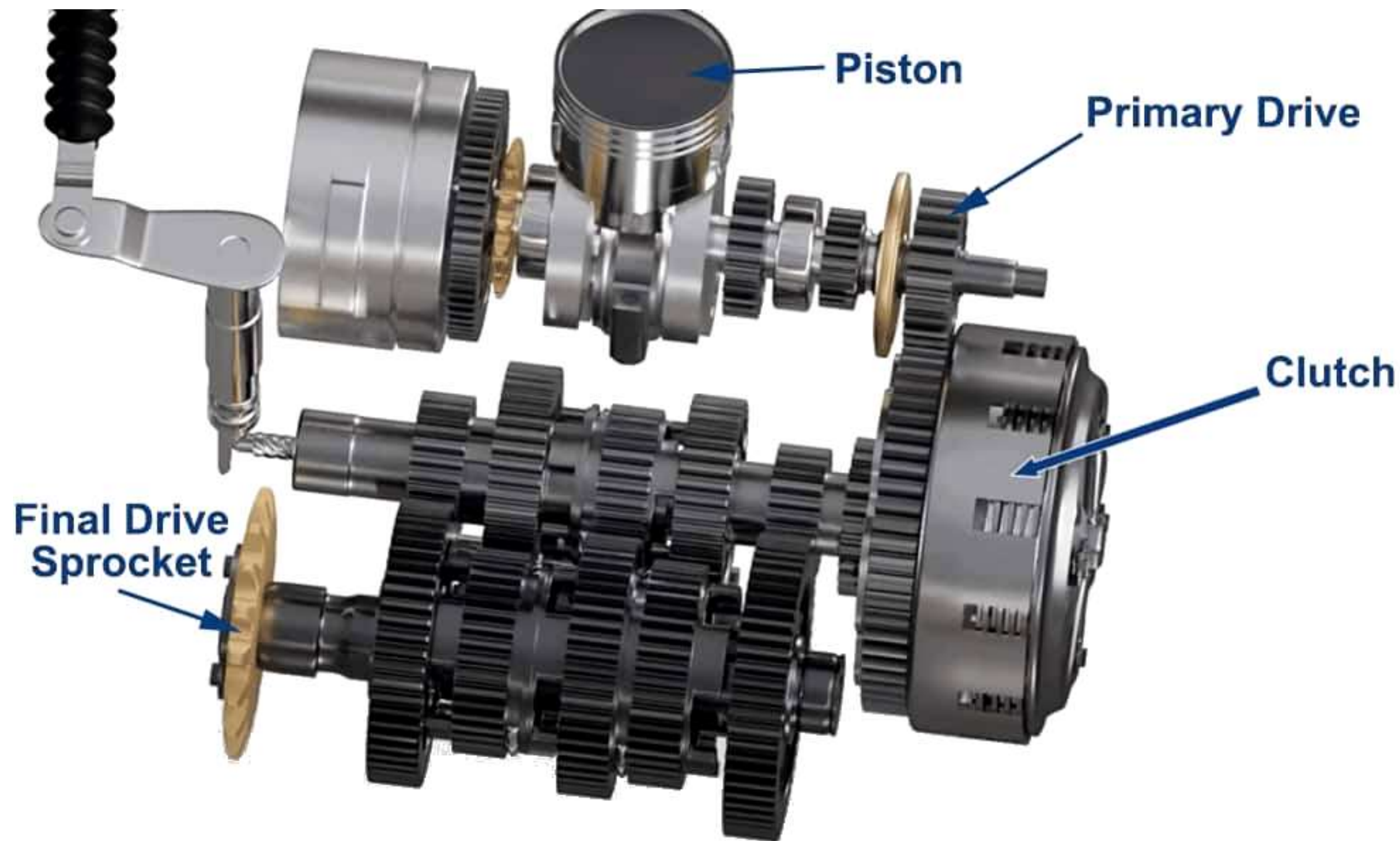
Transmission

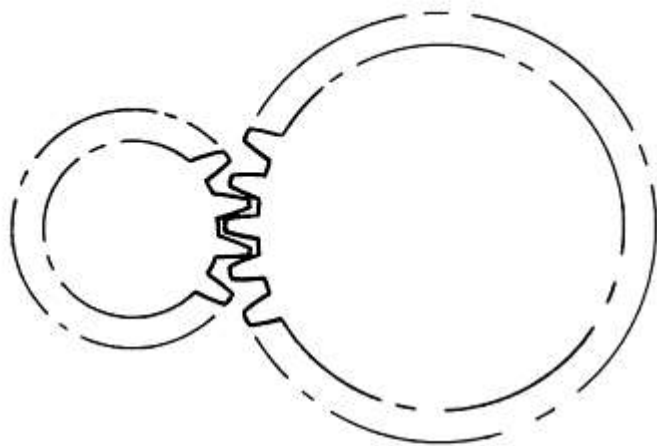
- In any vehicle (motorcycle or otherwise) a **transmission** has two main purposes:
- It allows the engine to spin free of the wheels when the vehicle is at rest.
- It keeps the engine speed in the correct range relevant to vehicle speed.
- Internal combustion engines have a relatively narrow power band. If the engine speed, measured in revolutions per minute (RPM), is either too high or too low, engine power and efficiency will not be optimal. Transmissions contain multiple gear ratios, which keep the engine RPM in an ideal range and allow the vehicle to accelerate from a stop, cruise at high speed, and everything in between.



Motorcycle Drive train



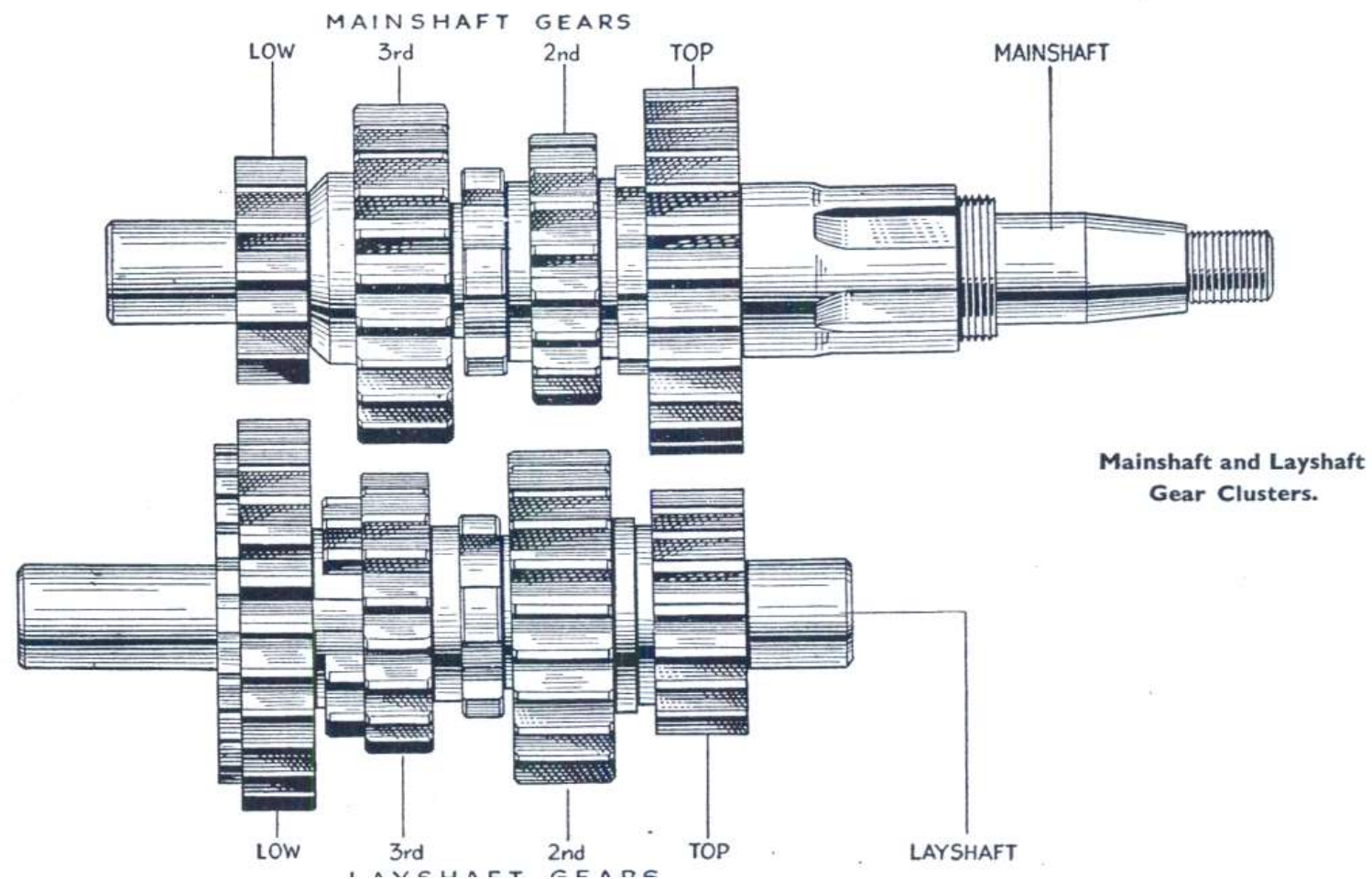




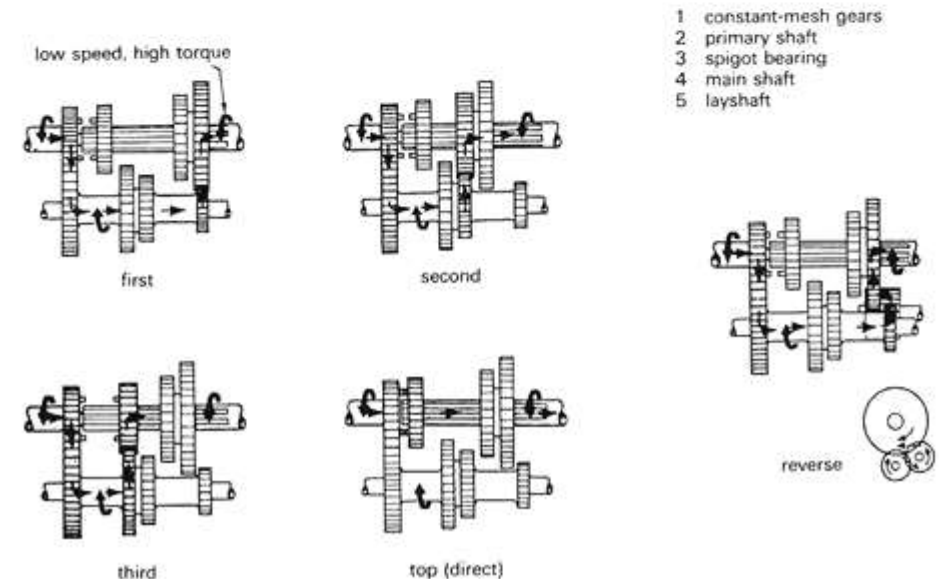
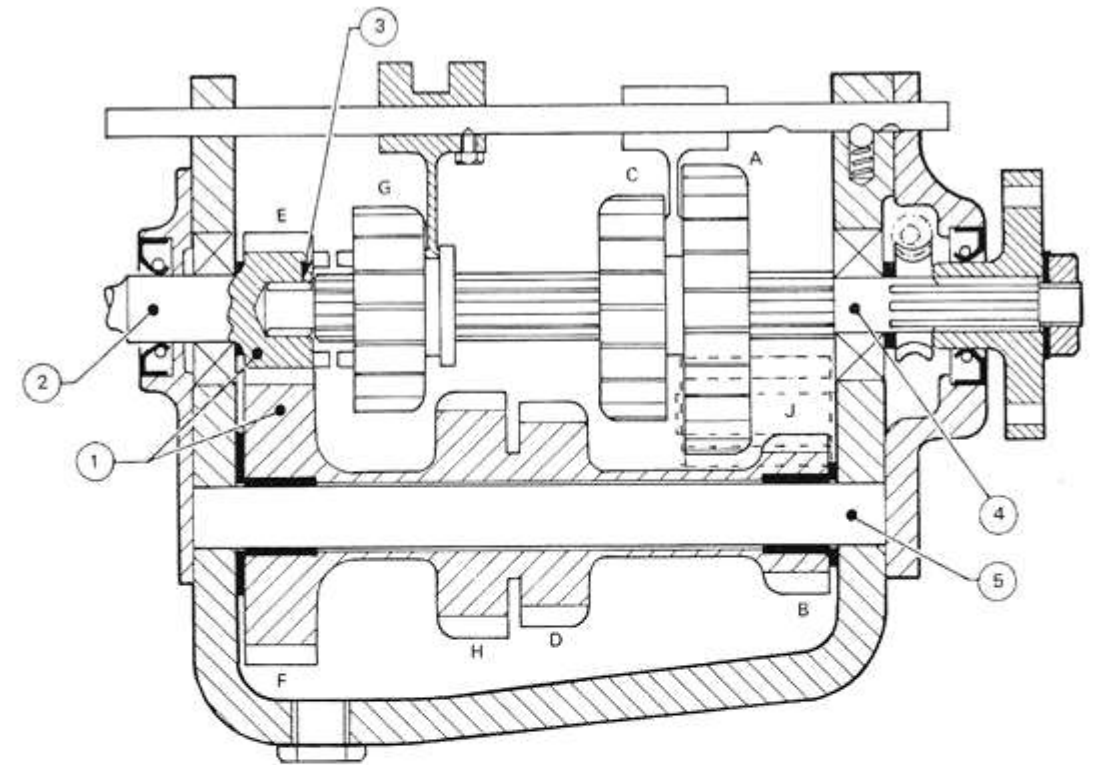
10-Tooth Primary Drive
10 ft.-lb. Torque
300 RPM

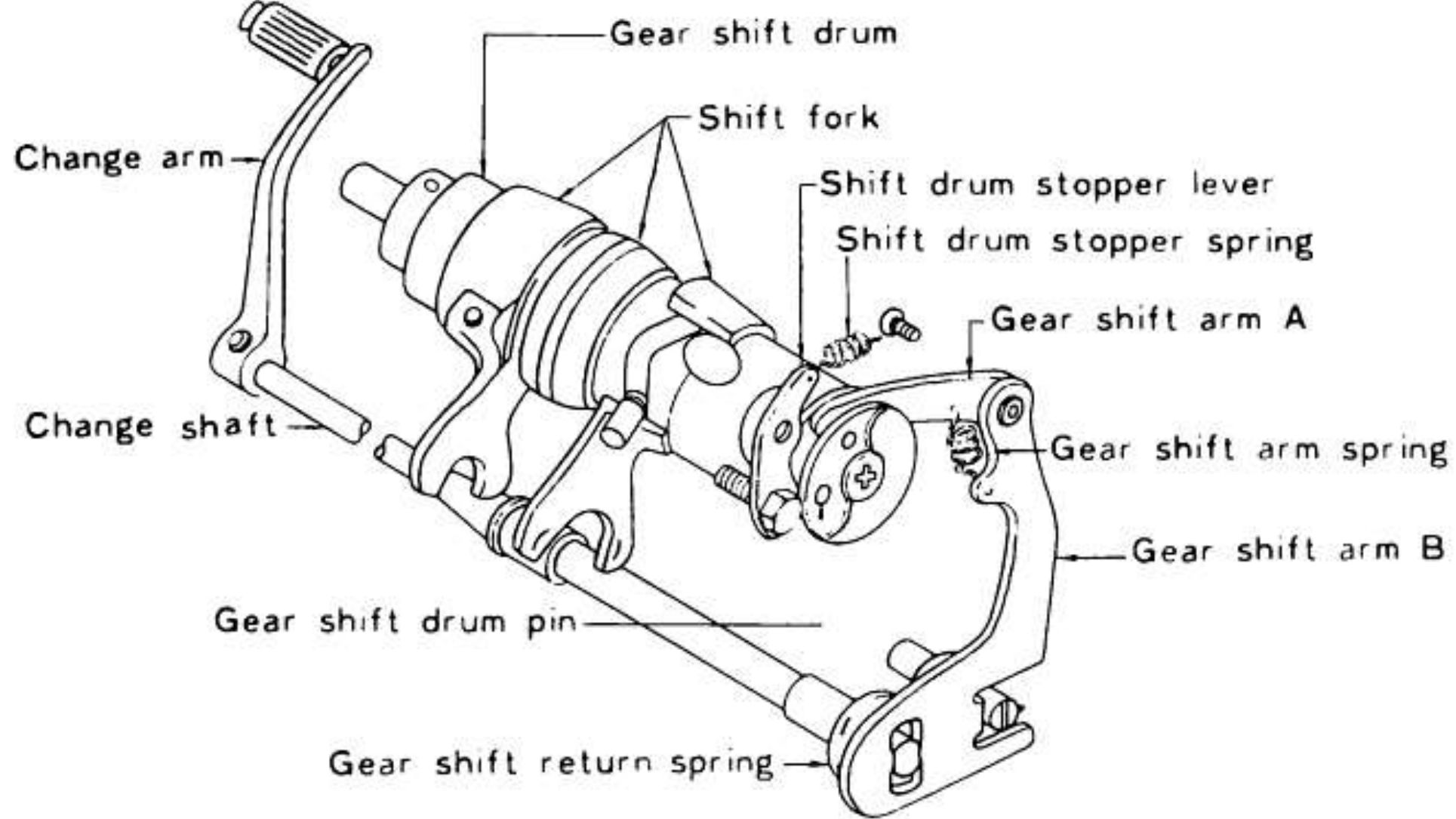
30-Tooth Driven Gear
30 ft.-lb. Torque
100 RPM

1-to-3 gear ratio, showing 10-tooth
primary and 30-tooth drive gear

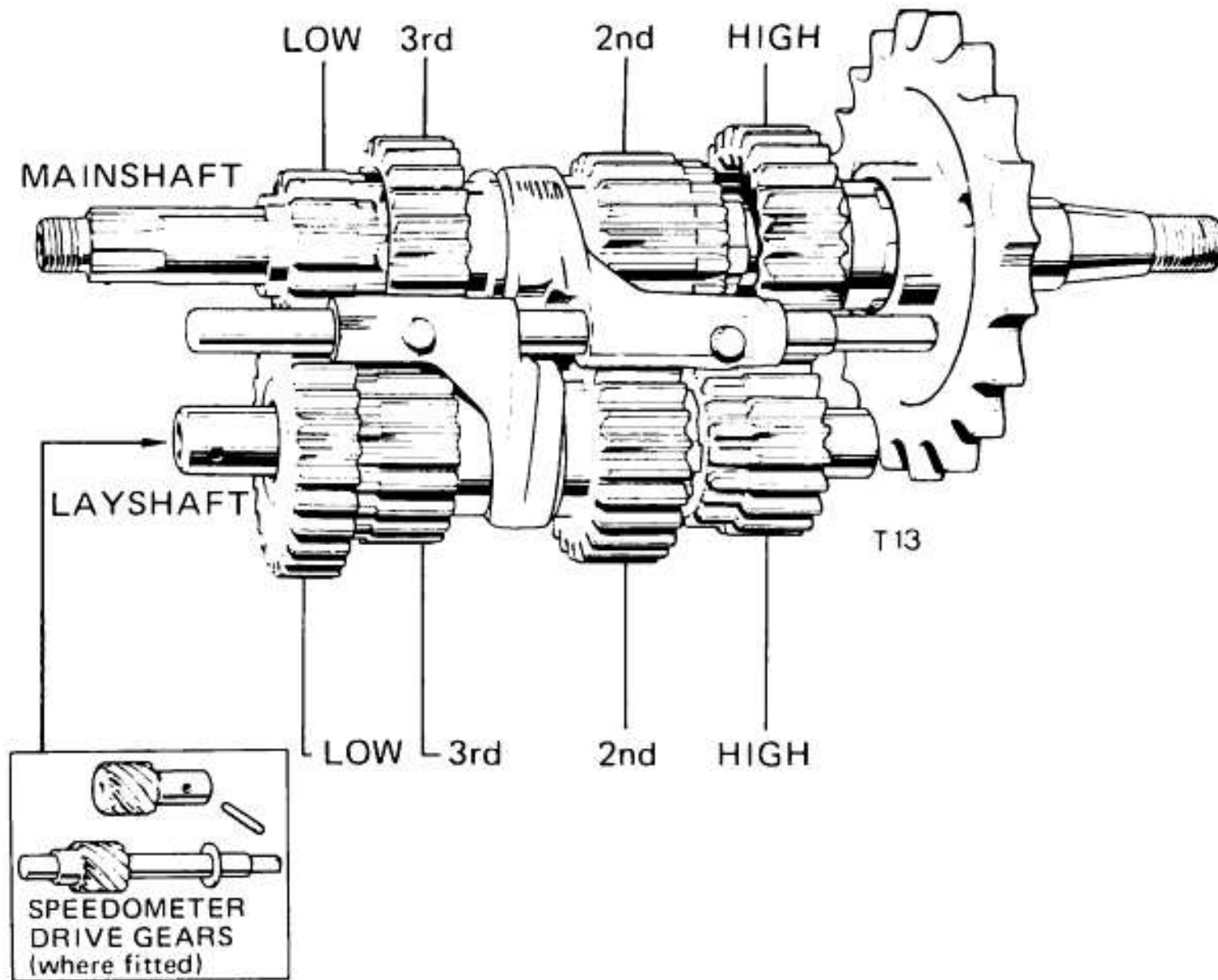


- **Sliding mesh gearbox** is a transmission system that consists of various sets of gears and shafts that are arranged together in an organized fashion and the shifting or meshing of different gear ratios is done by the sliding of gears towards the right and left over the splined shaft with the help of a gear lever operated by the driver

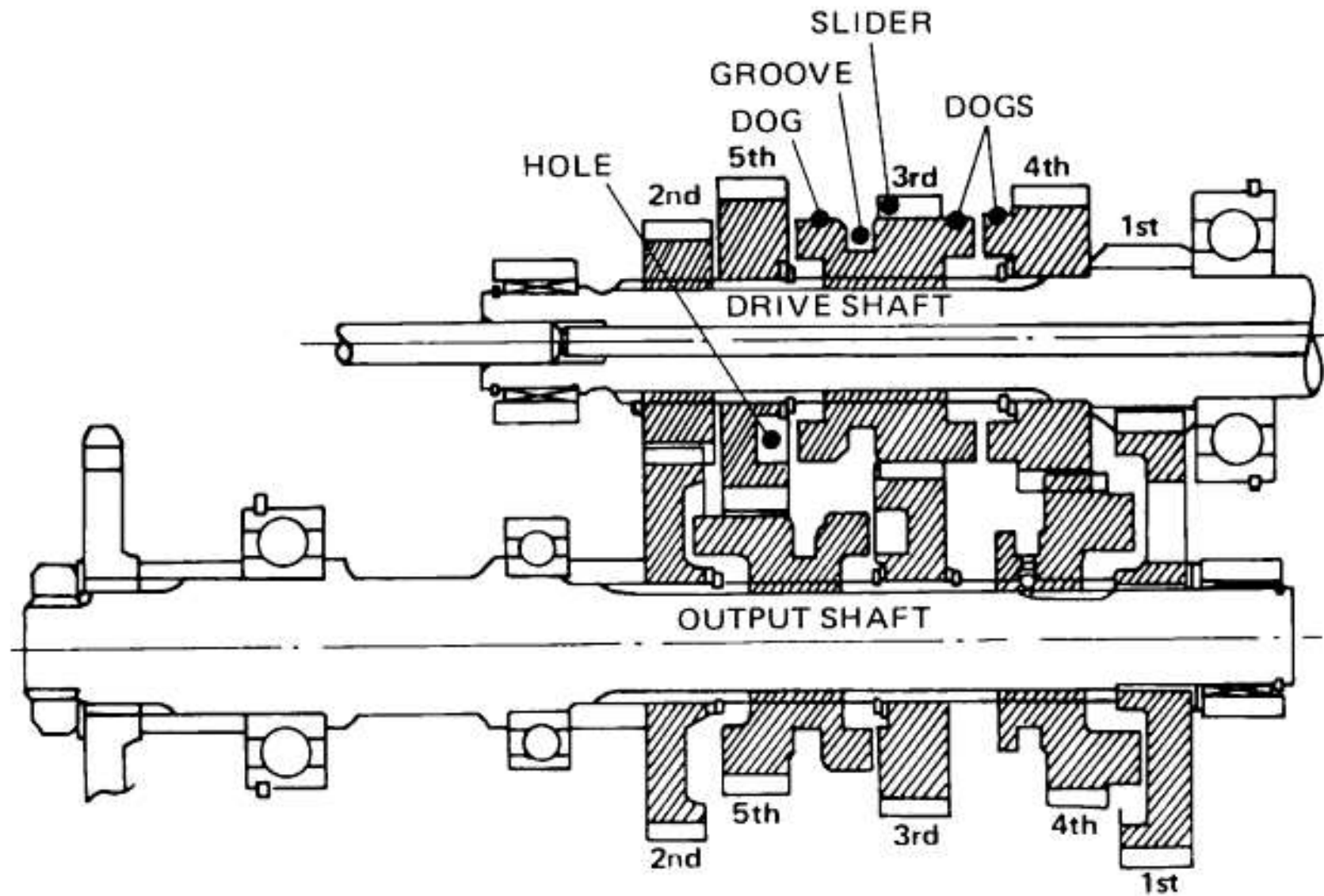




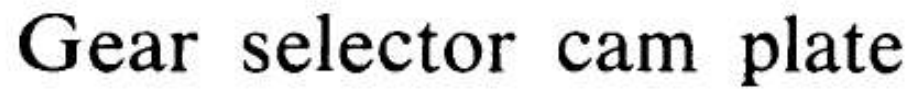
Shifting fork mechanism (Yamaha International Corporation)



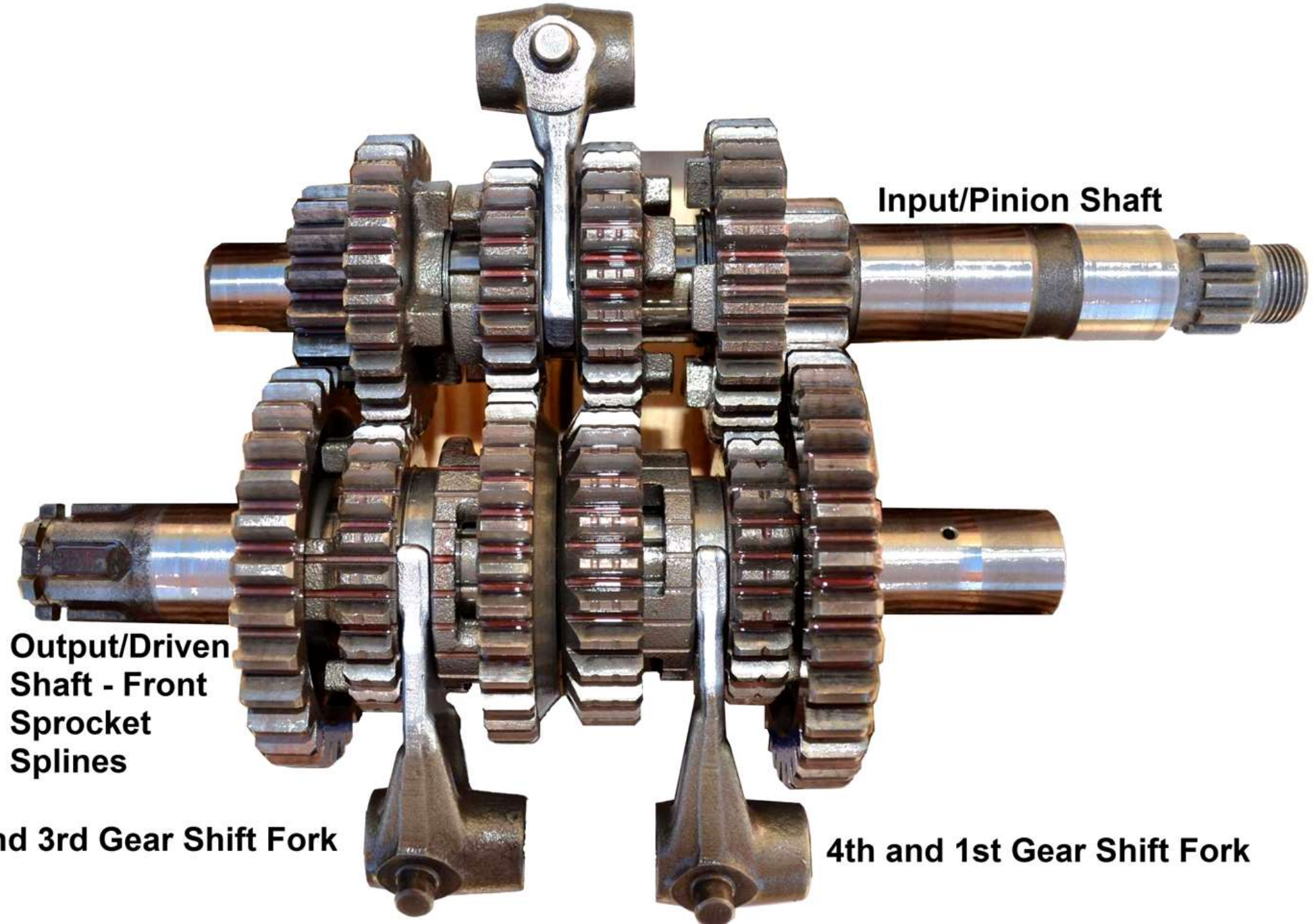
Transmission components



Transmission cross section



5th and 6th Gear Shift Fork



Input/Pinion Shaft

**Output/Driven
Shaft - Front
Sprocket
Splines**

2nd and 3rd Gear Shift Fork

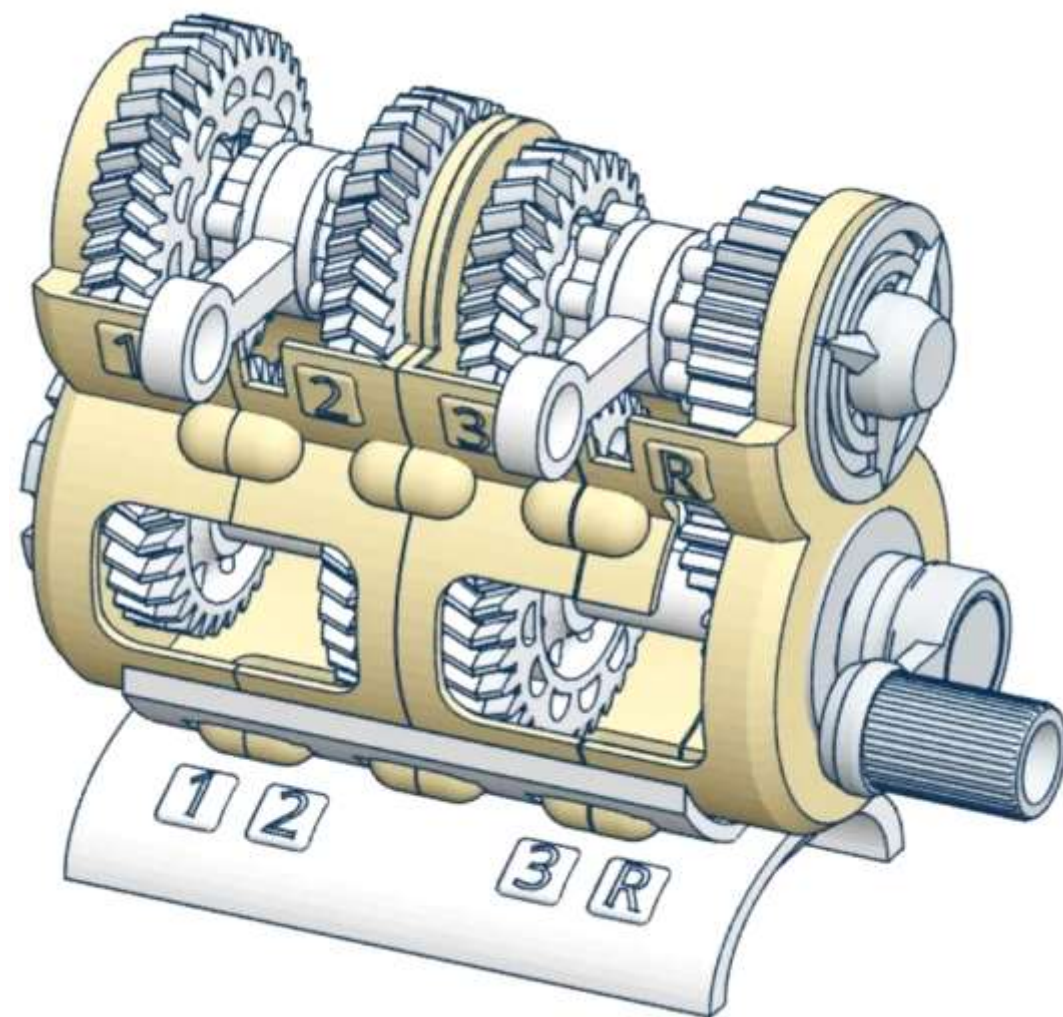
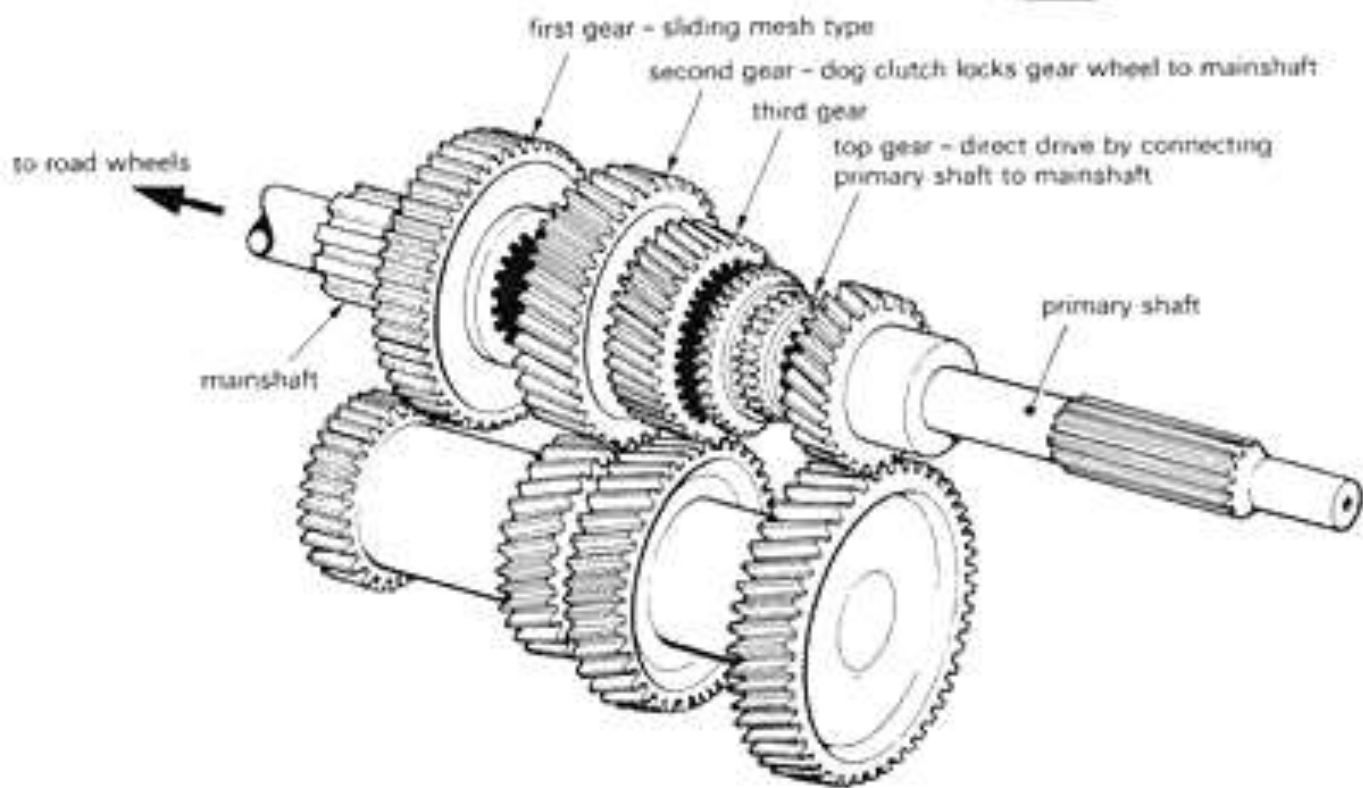
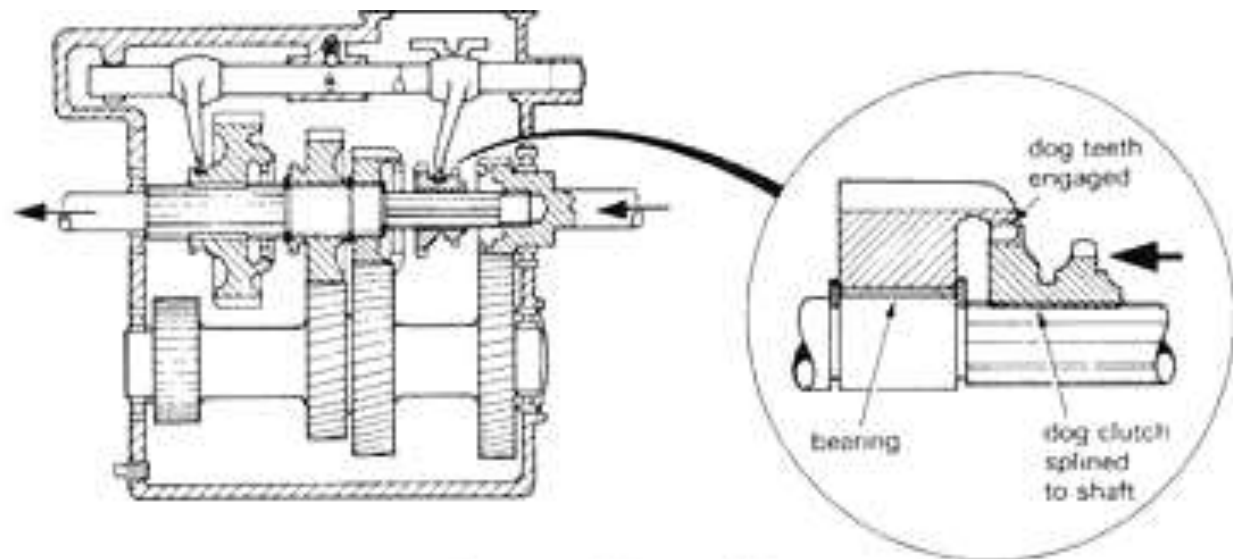
4th and 1st Gear Shift Fork

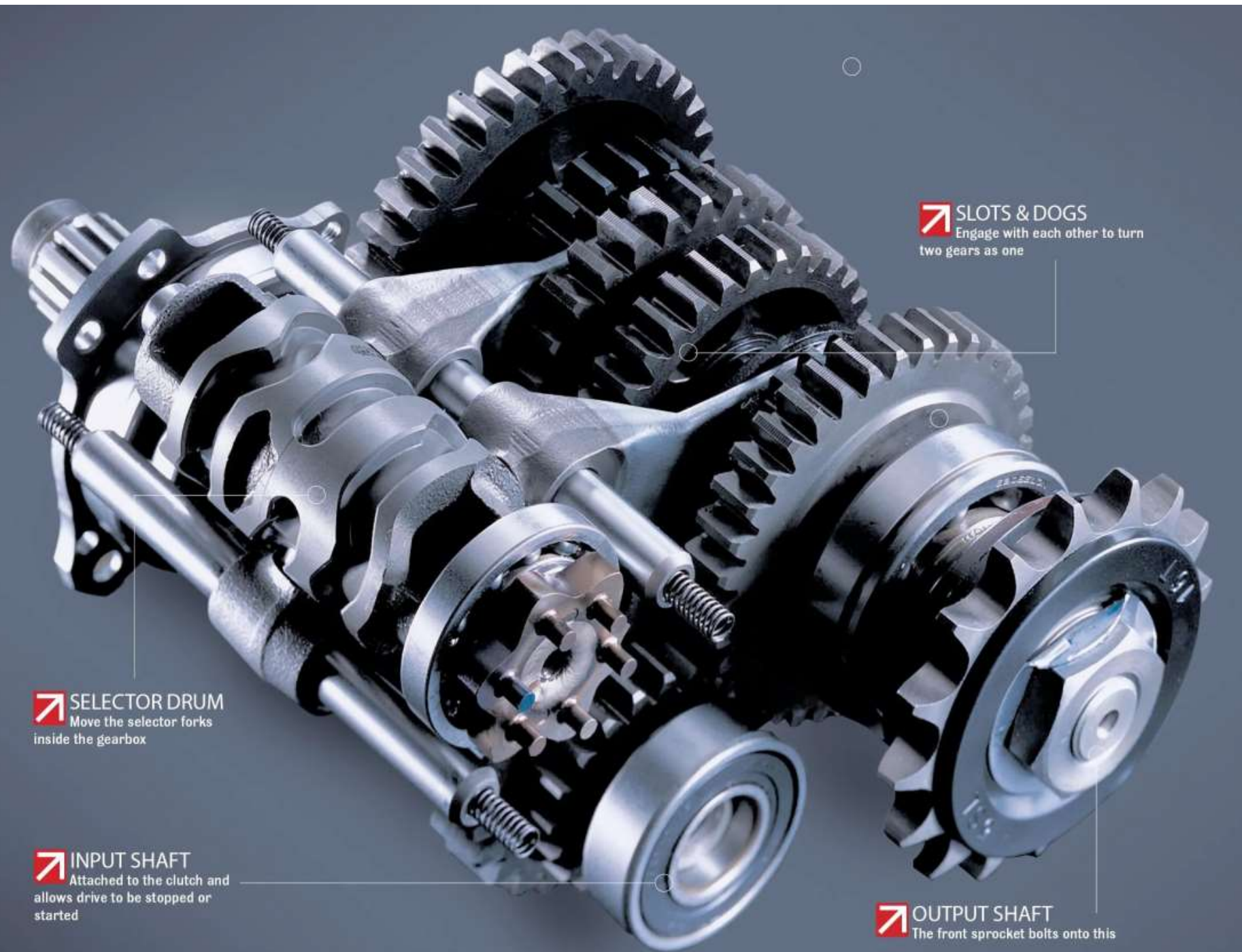
- **Constant mesh**
- Most modern manual motorcycle gearboxes have "constant-mesh" gears which are always mated but may rotate freely on a shaft until locked by a toothed sliding collar, or "dog clutch". Since the gears are always rotating and can only be accessed sequentially, synchromesh is not generally needed



- The gears used in a manual transmission constant mesh are helical and double helical and are quieter during operation. Because the gears in a constant-mesh gearbox are in constantly meshing, it's less likely to damage the gear teeth, and there's typically less wear on the gears.







SECTOR DRUM
Move the selector forks
inside the gearbox

INPUT SHAFT
Attached to the clutch and
allows drive to be stopped or
started

SLOTS & DOGS
Engage with each other to turn
two gears as one

OUTPUT SHAFT
The front sprocket bolts onto this

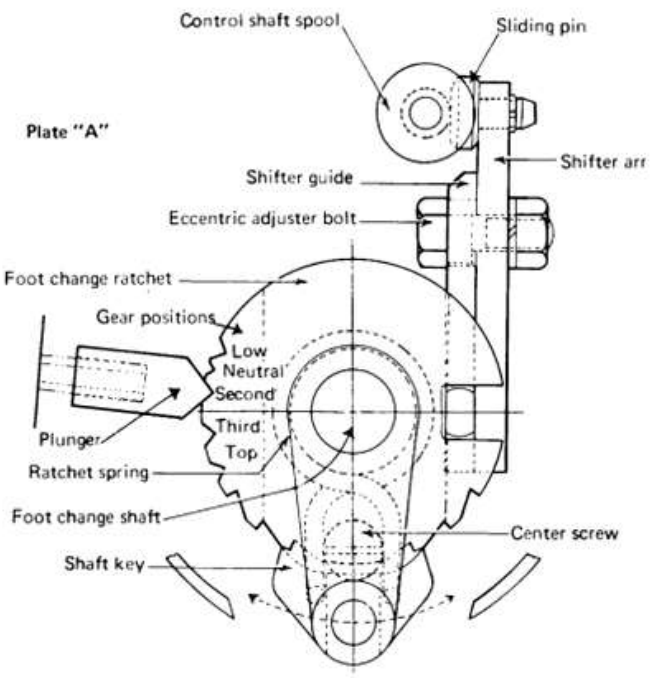


Plate "B"

Neutral position

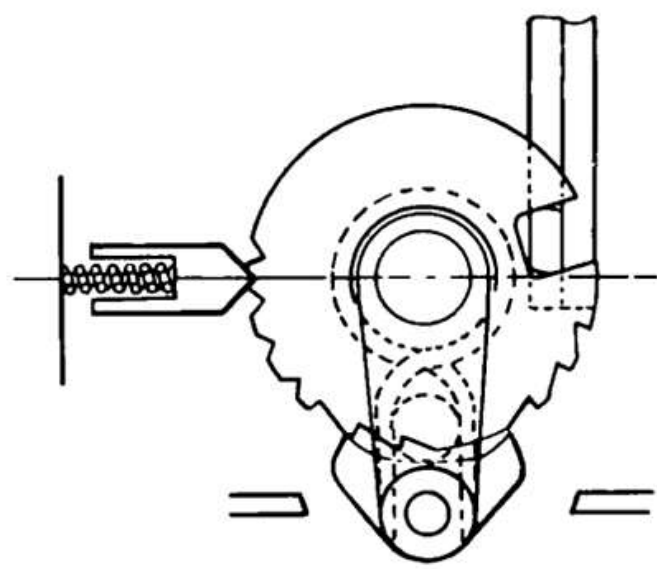


Plate "C"

Low gear engaged

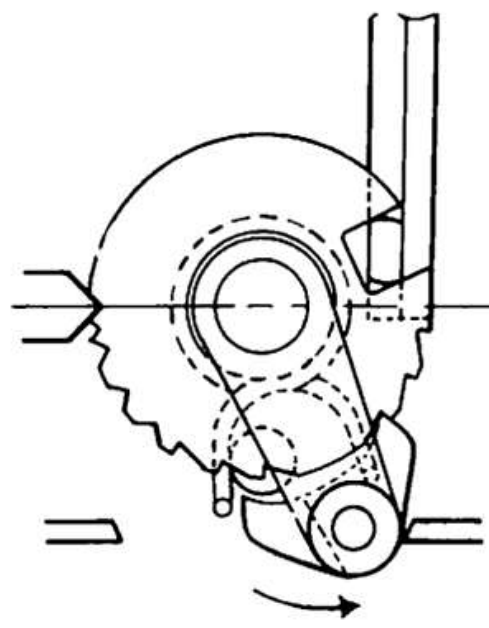
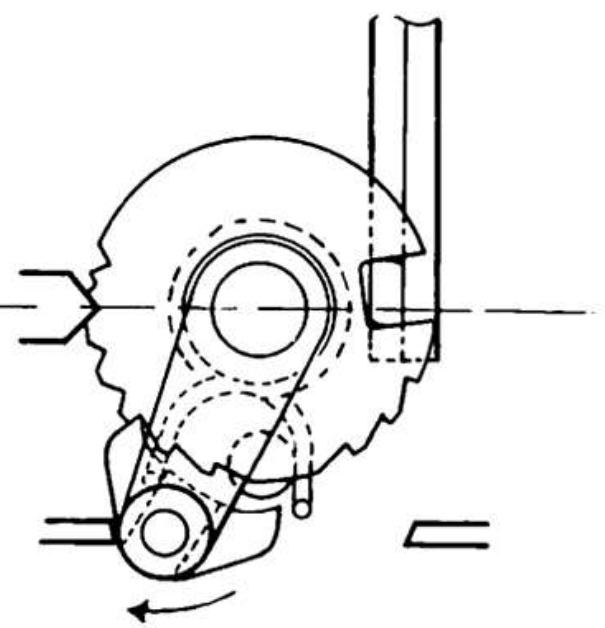
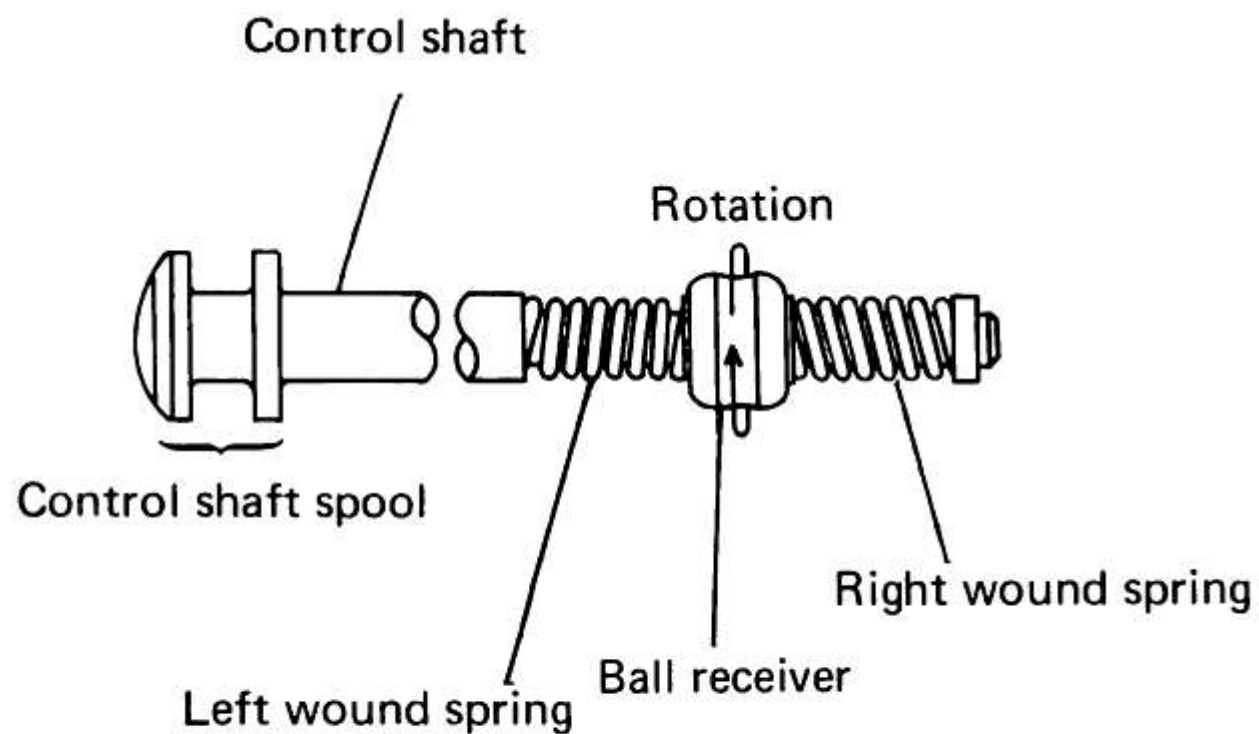


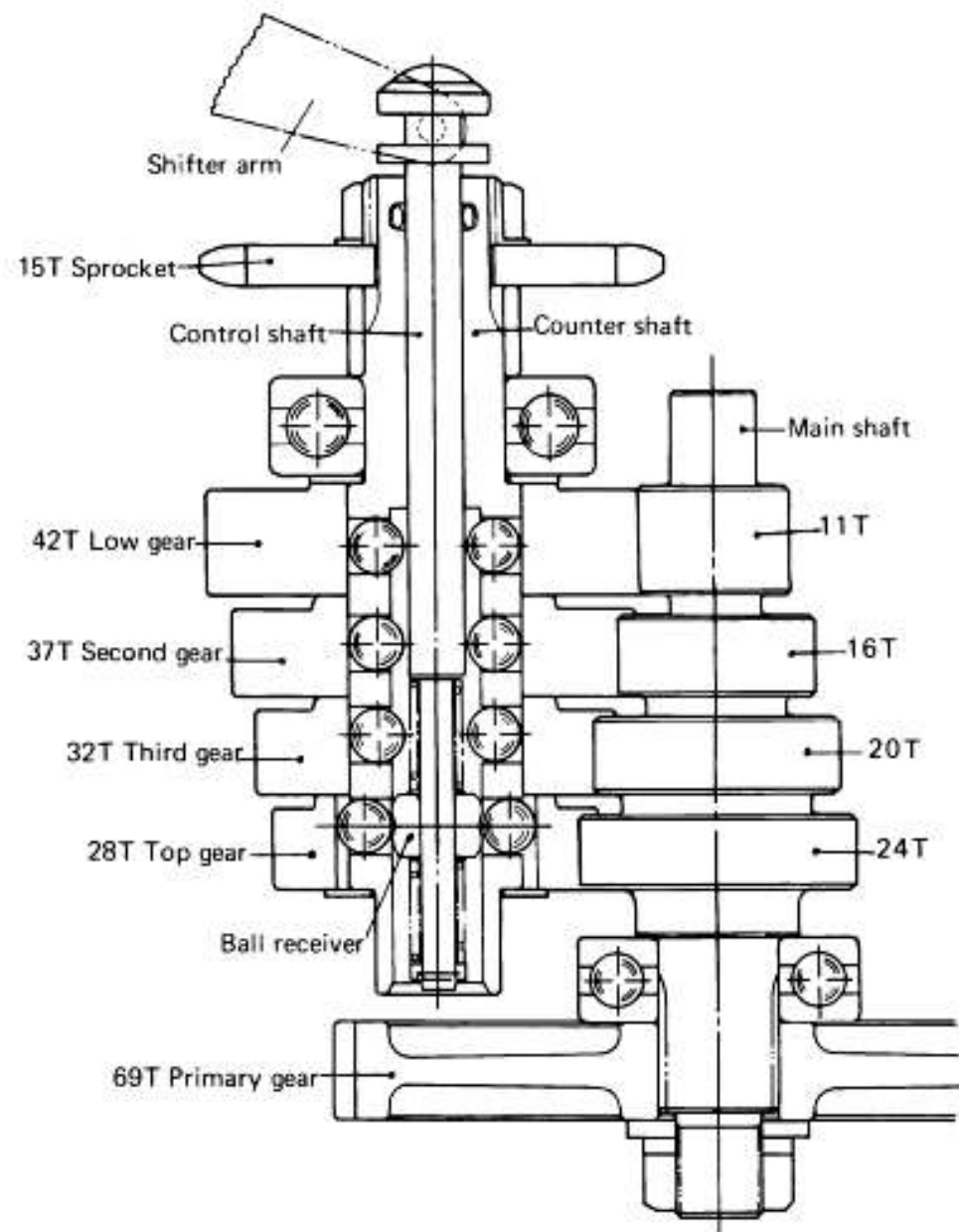
Plate "D"

Second gear engaged





Ball receiver (Pabatco)

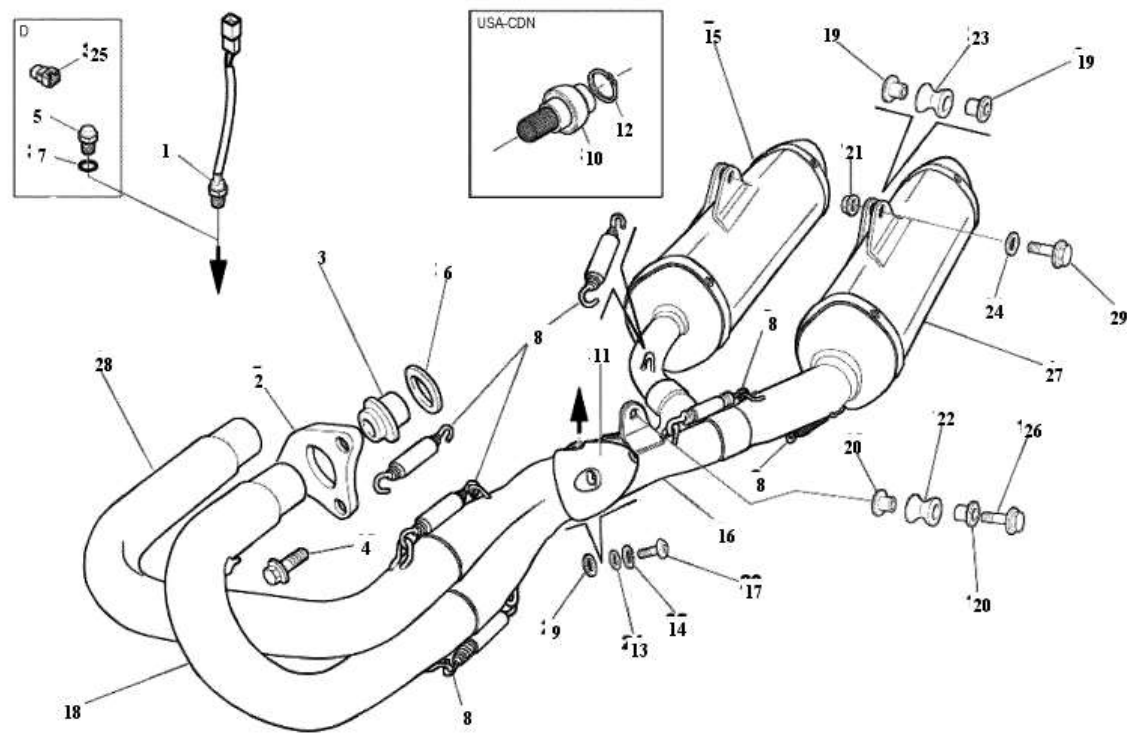


Cross section of engaged fourth gear (Pabatco)

EXHAUST SYSTEM

- The exhaust system collects the exhaust gases from the cylinders, removes harmful substances, reduces the level of noise and discharges the purified exhaust gases at a suitable point of the vehicle away from its occupants.





Motorcycles are fitted with exhausts for a few reasons:

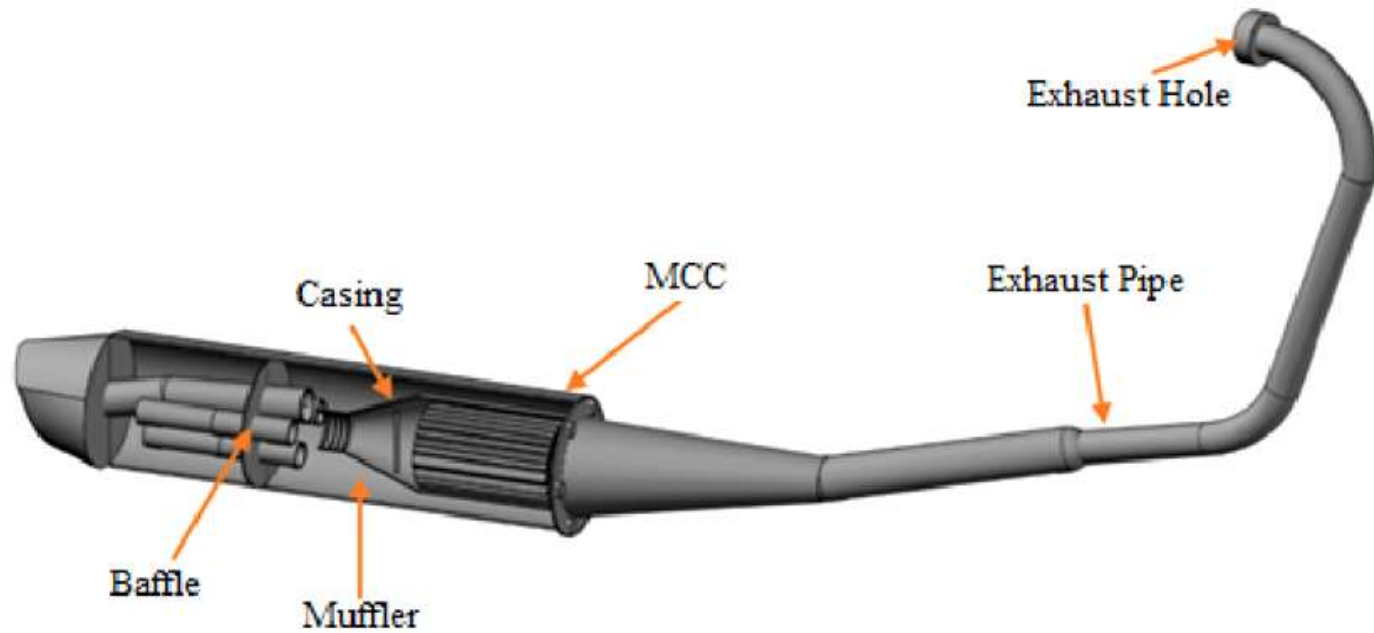
- **They route combustion gases away** from rider and passenger. You and your passenger don't want to suck down a carbon monoxide cocktail or burn your boots on a hot pipe, right? Exhaust pipes move exhaust to a more convenient place!
- **They muffle noise.** Putting a muffler on an engine is a wonderful way to make it reasonably quiet. If you've ever been to the track, dragstrip, or your local muffler shop, you have some idea of how face-meltingly *loud* a vehicle is with no exhaust system.
- **They help the engine perform better.** Believe it or not, bolting a simple tube on a motor can actually help it run lots better. There's an amazing body of research dedicated just to exhaust in fields like thermodynamics and laminar flow, but suffice it to say that the right exhaust can help you go faster



- **Scavenging** occurs when the rush of exhaust gas leaving the cylinder helps to pull in a fresh air/fuel mixture. During the exhaust stroke, the exhaust gases escape the cylinder very quickly. This creates a high-speed pulse moving down the header tube. The low pressure behind the exhaust pulse creates a vacuum effect.

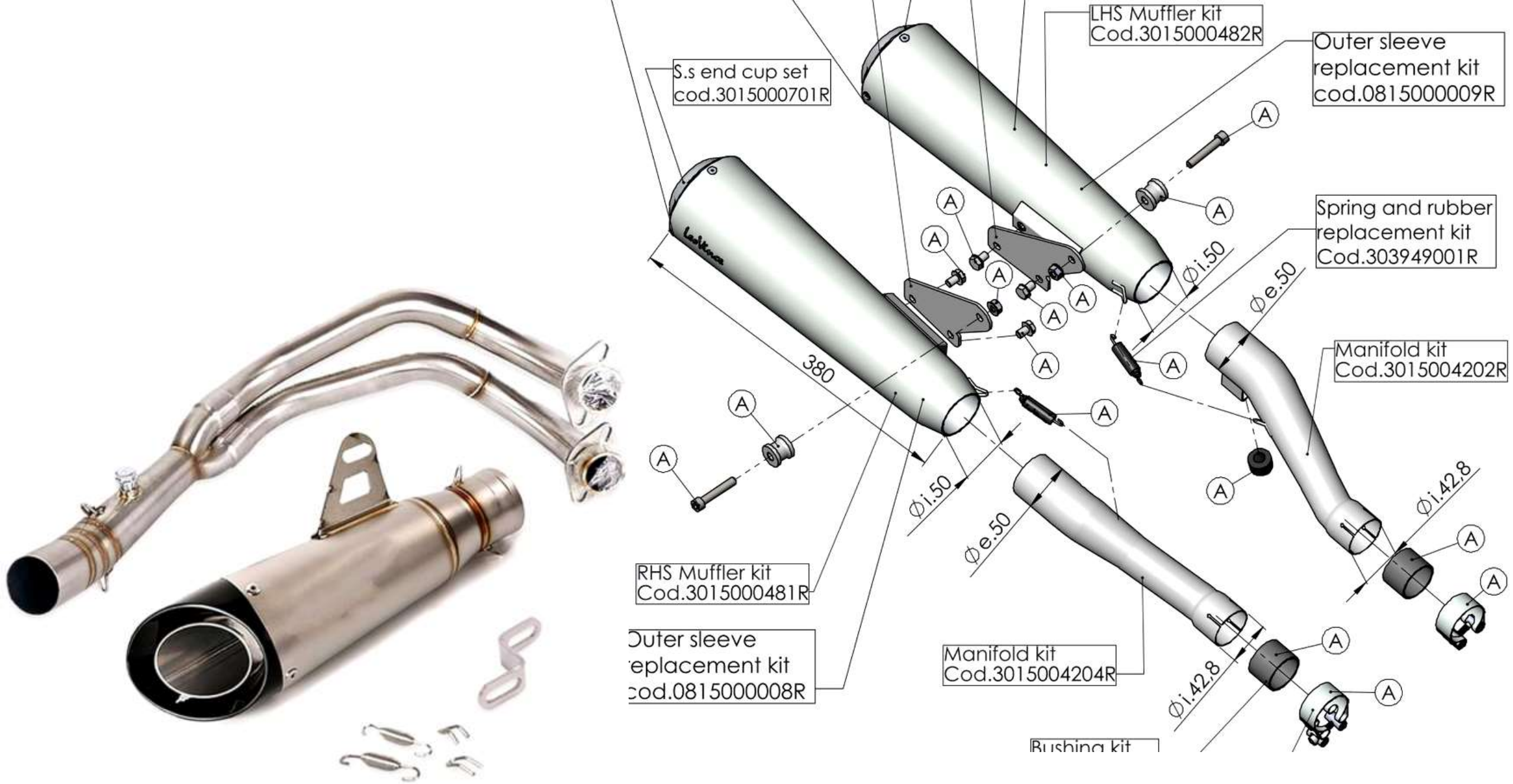


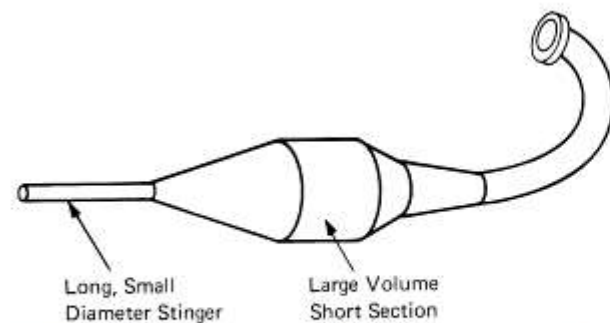
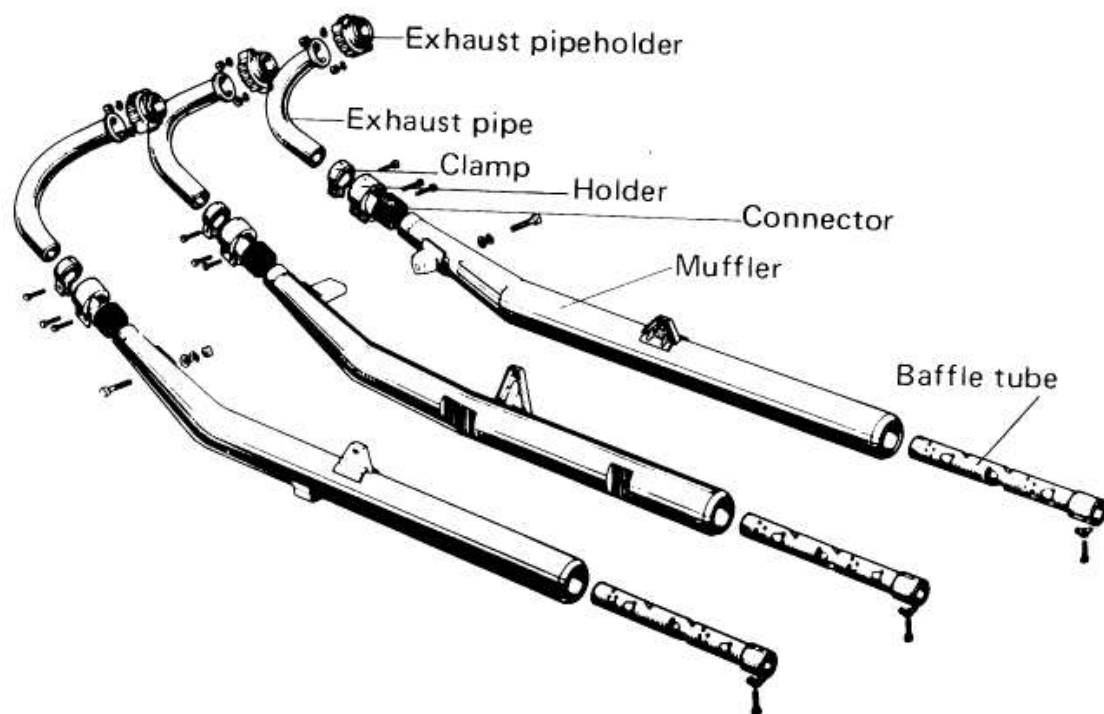
Pipe Design



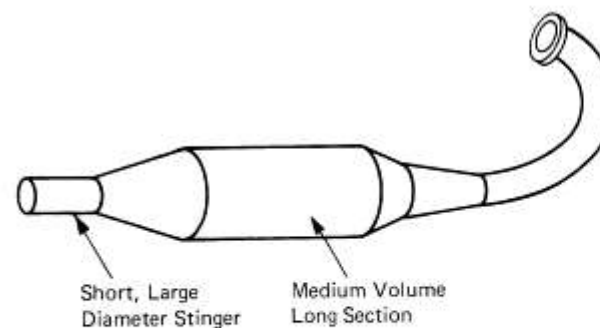
**motorcycle exhaust
megaphone (Silencer)**



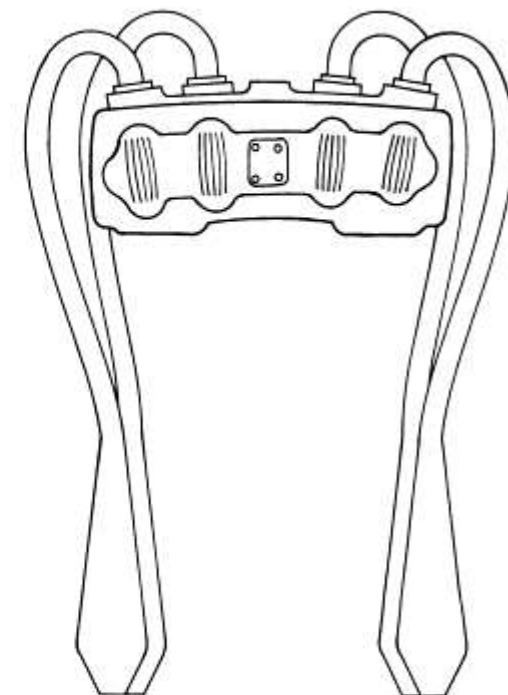




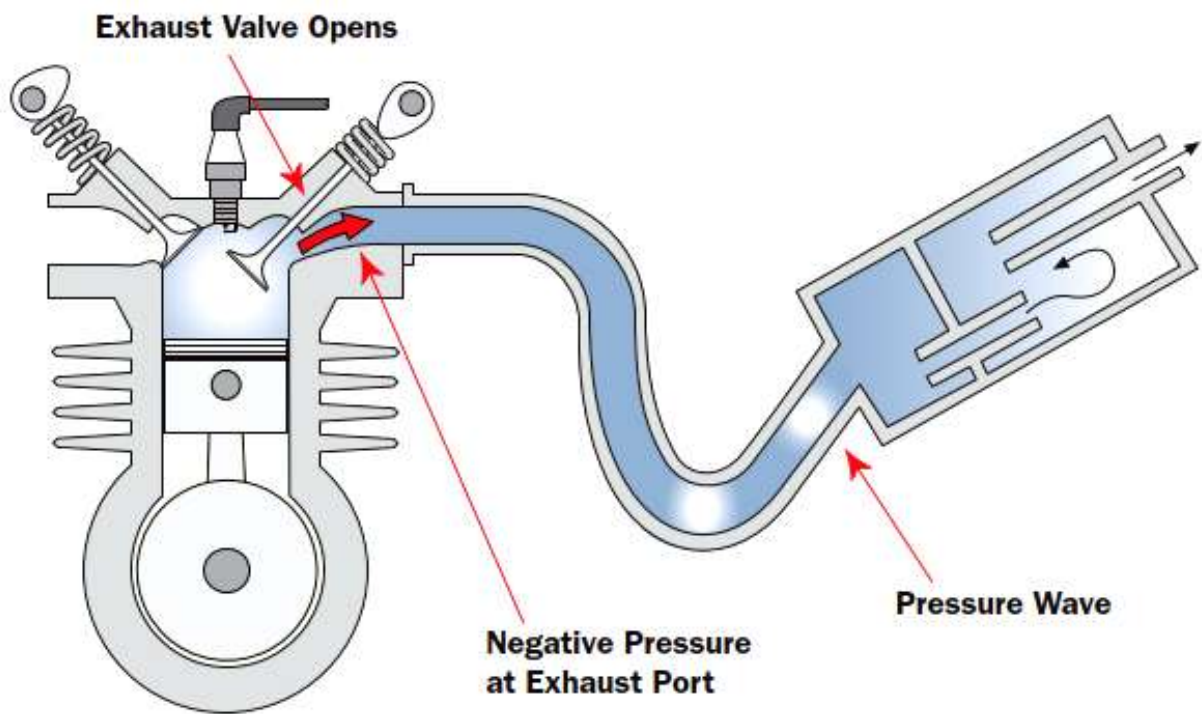
High Engine RPM Expansion Chamber



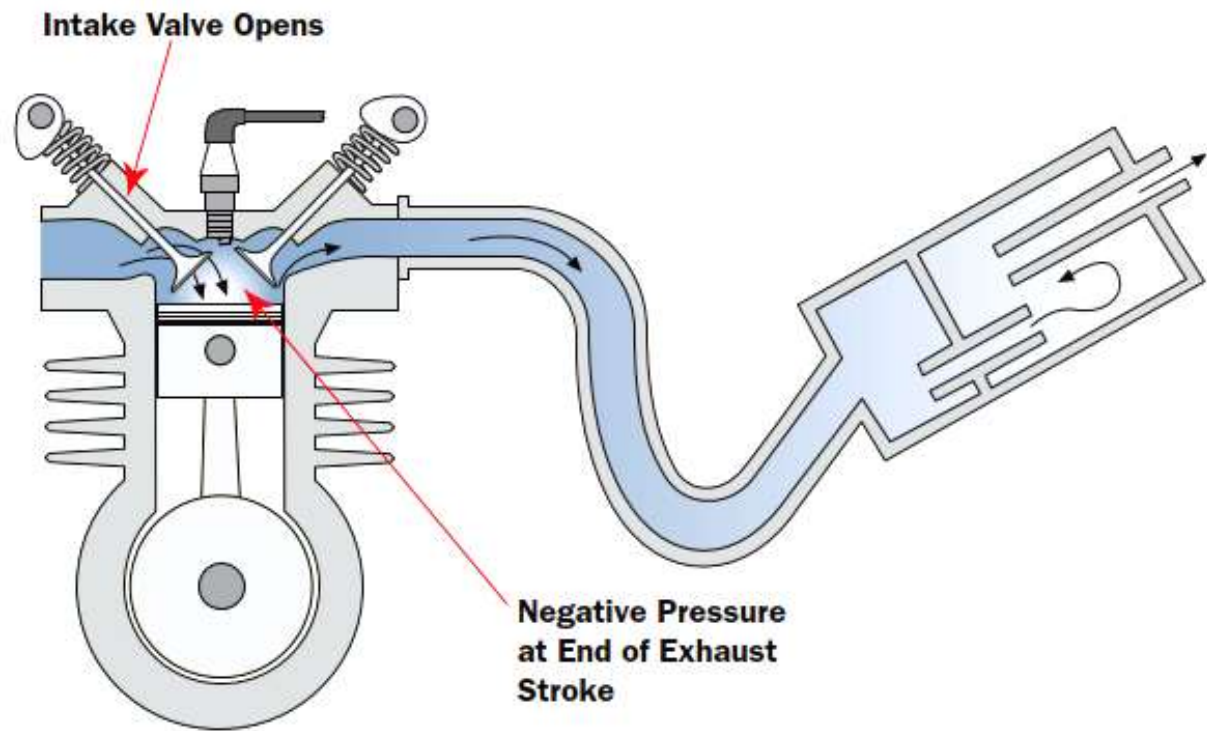
Medium Engine RPM Expansion Chamber



Top view 4-Cylinder engine exhaust

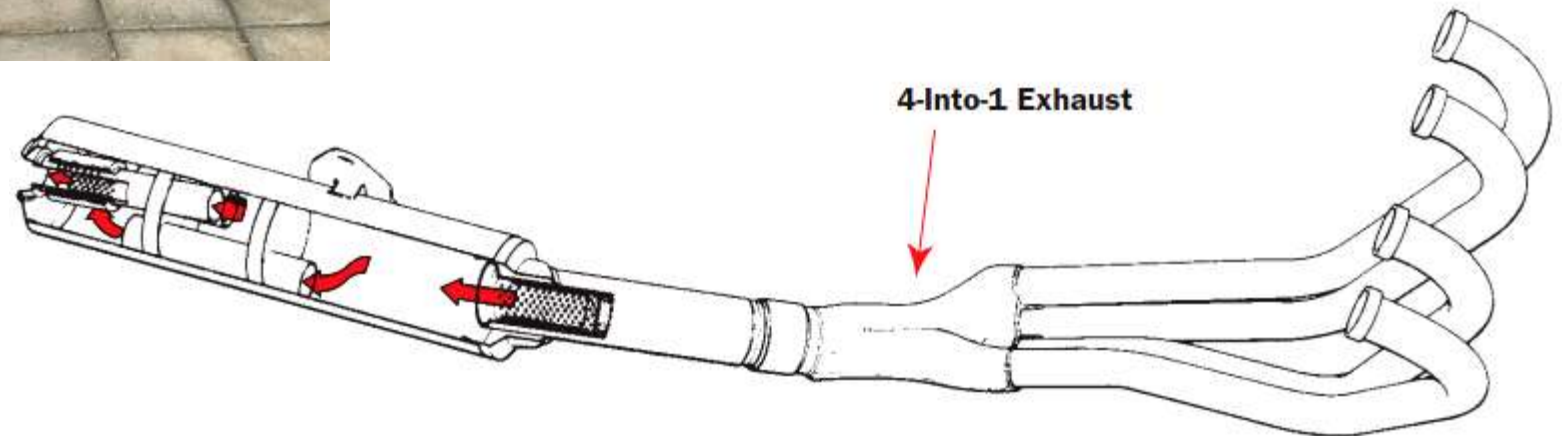


During the exhaust stroke a negative pressure (vacuum) is created at the exhaust port.



*During the valve overlap period, when the exhaust valve hasn't fully closed and the intake has started to open the vacuum pulse in the exhaust system helps pull the fresh charge into the combustion chamber.
(Courtesy American Honda Motor Corporation)*

Crossover Tubes and Collectors



4-Into-1 Exhaust

Typical four-stroke baffle-type muffler.

- By providing another point of expansion, **crossover** tubes which are often quite small can broaden the rpm range over which the negative wave arrives during overlap, thereby improving cylinder filling and power



- The **collector** is where the primary tubes merge together. "4-1" and "Tri-Y" are the 2 main types of collector design. The 4-1 design brings all 4 primary tubes into one collector at the same point. The Tri-Y design (or 4-2-1) merges the 4 primary tubes into 2 secondary tubes



4-1 Style Headers

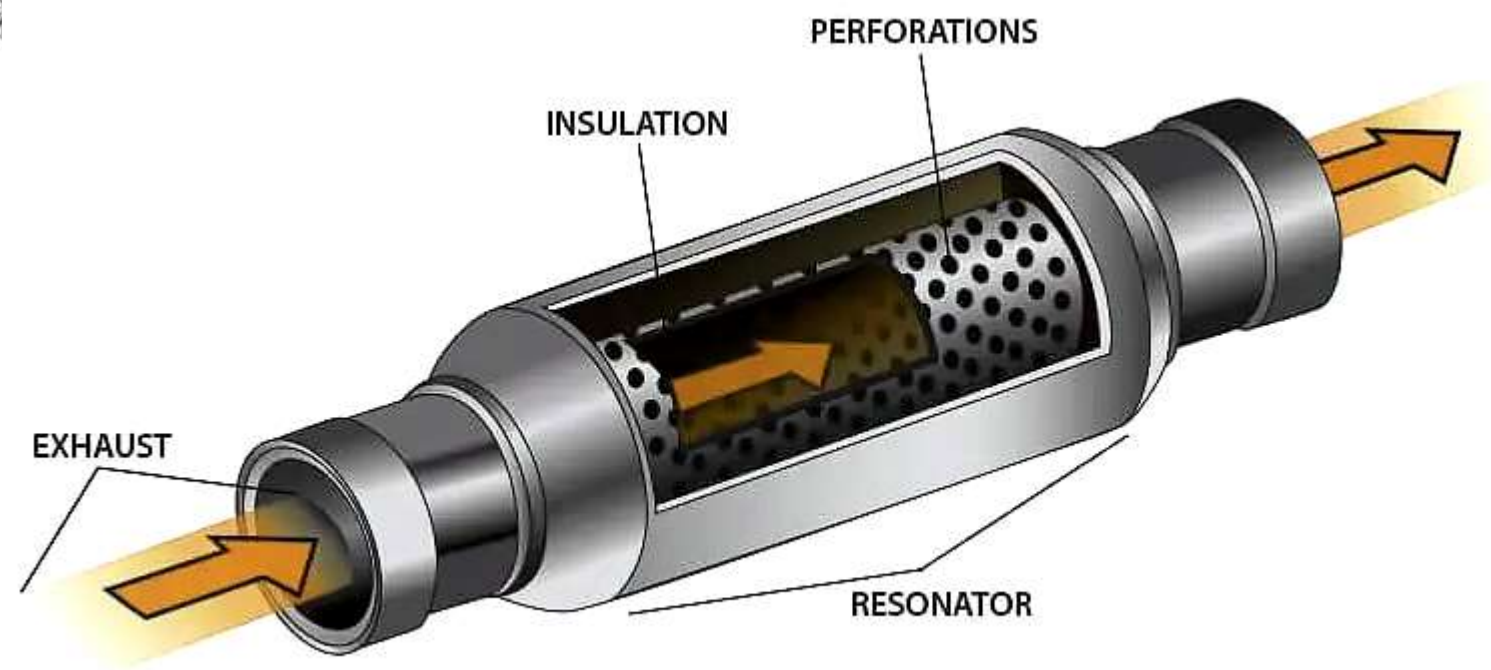


Tri-Y Style Headers



- **Mufflers** The muffler takes the exhaust gas out of the engine. Diffuses it it controls the noise. And it also somewhat controls our emissions out of the back
- The main benefits of a muffler include horsepower, sound, and fuel economy. A muffler facilitates the removal of exhaust fumes from the engine and fresh air intake into the engine to generate additional power





Final Drives

- Your motorcycles final drive is what connects power from the engine to the rear wheel to make it go.



- There are three basic ways to transmit engine power to the rear wheel of a motorcycle, either by a chain, belt or shaft these are referred to as your 'final drive' the thing that finally gets you driving/moving.

Chain



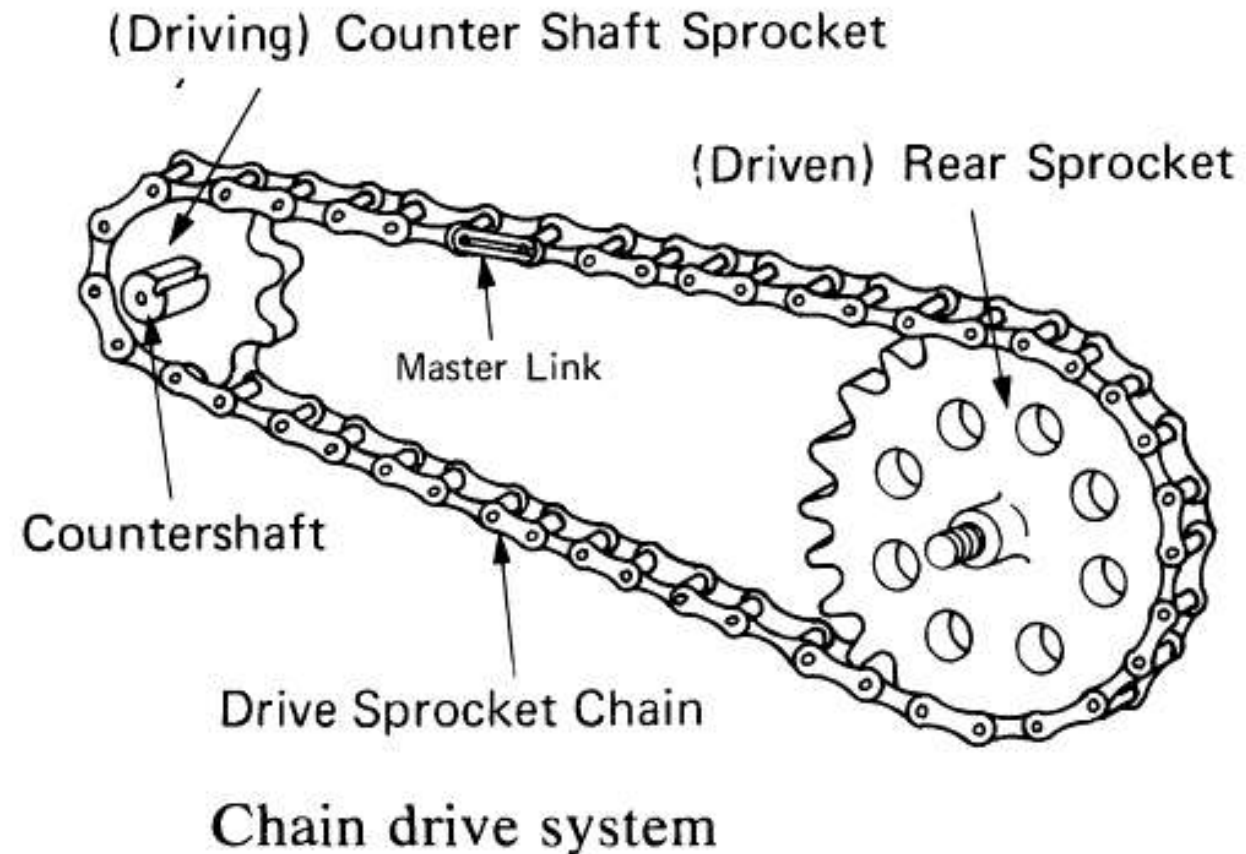
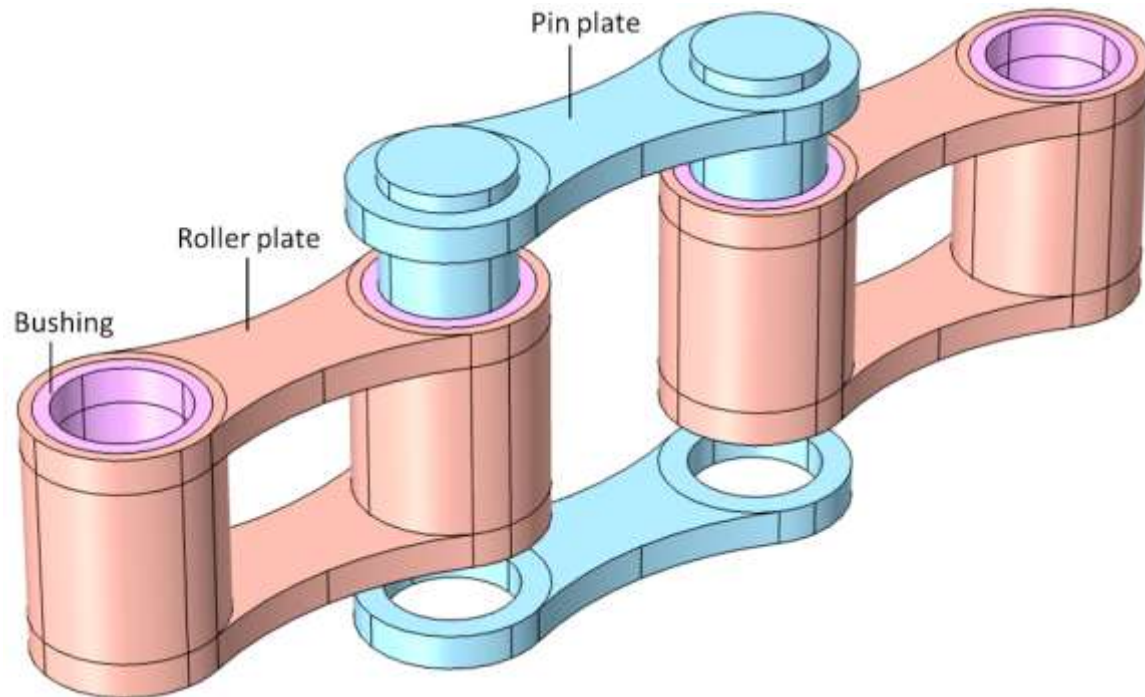
Belt

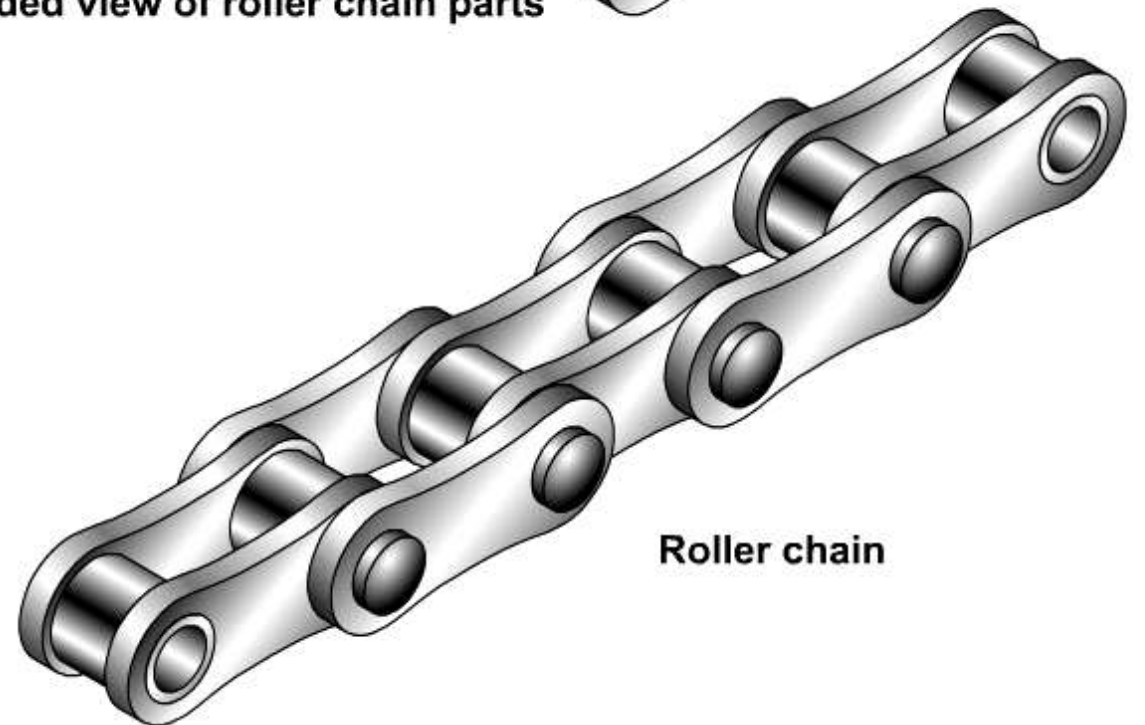
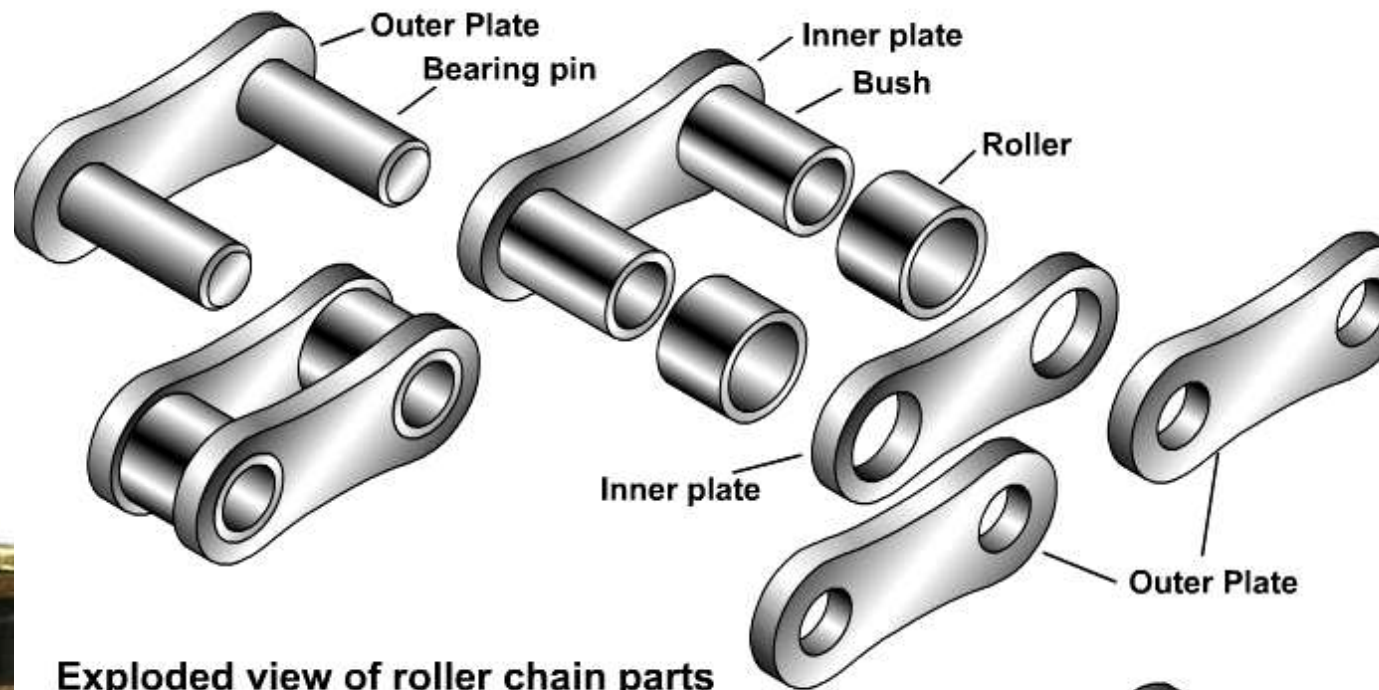


Shaft



- **Chain Drive Component:** The Chain drive is the most popular used method of driving the rear wheel of a motorcycle. In this system, In this system a sprocket mounted to the output shaft, and is connected to a sprocket attached to the rear wheel.

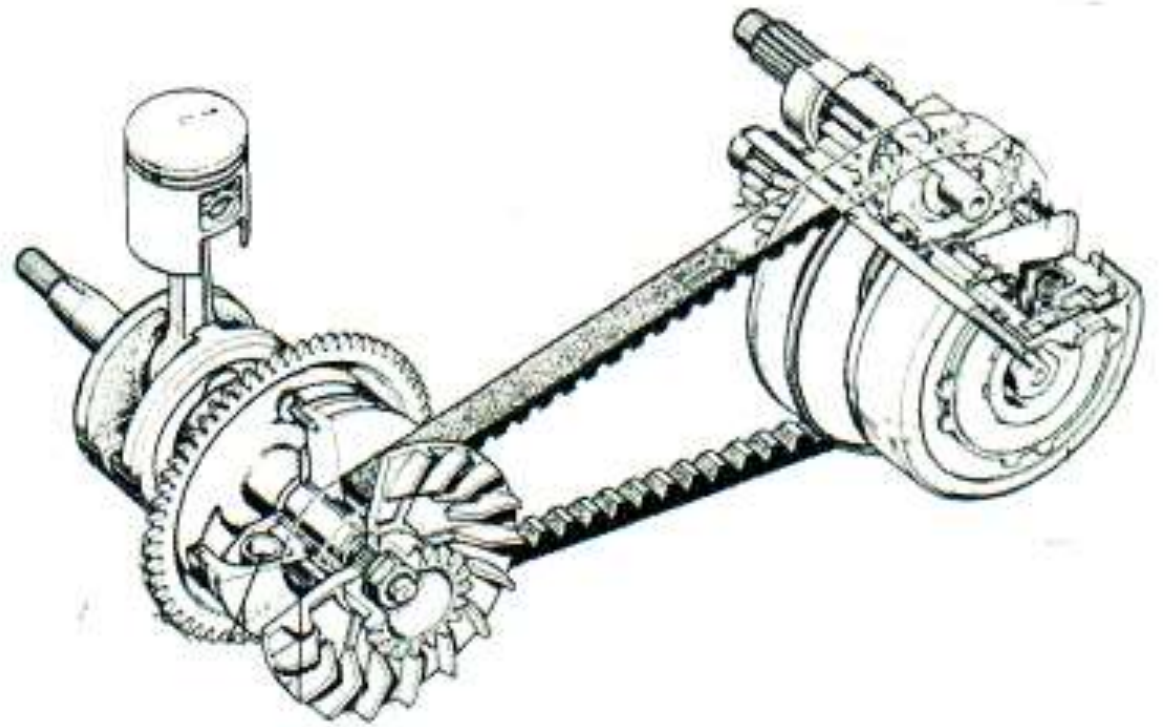


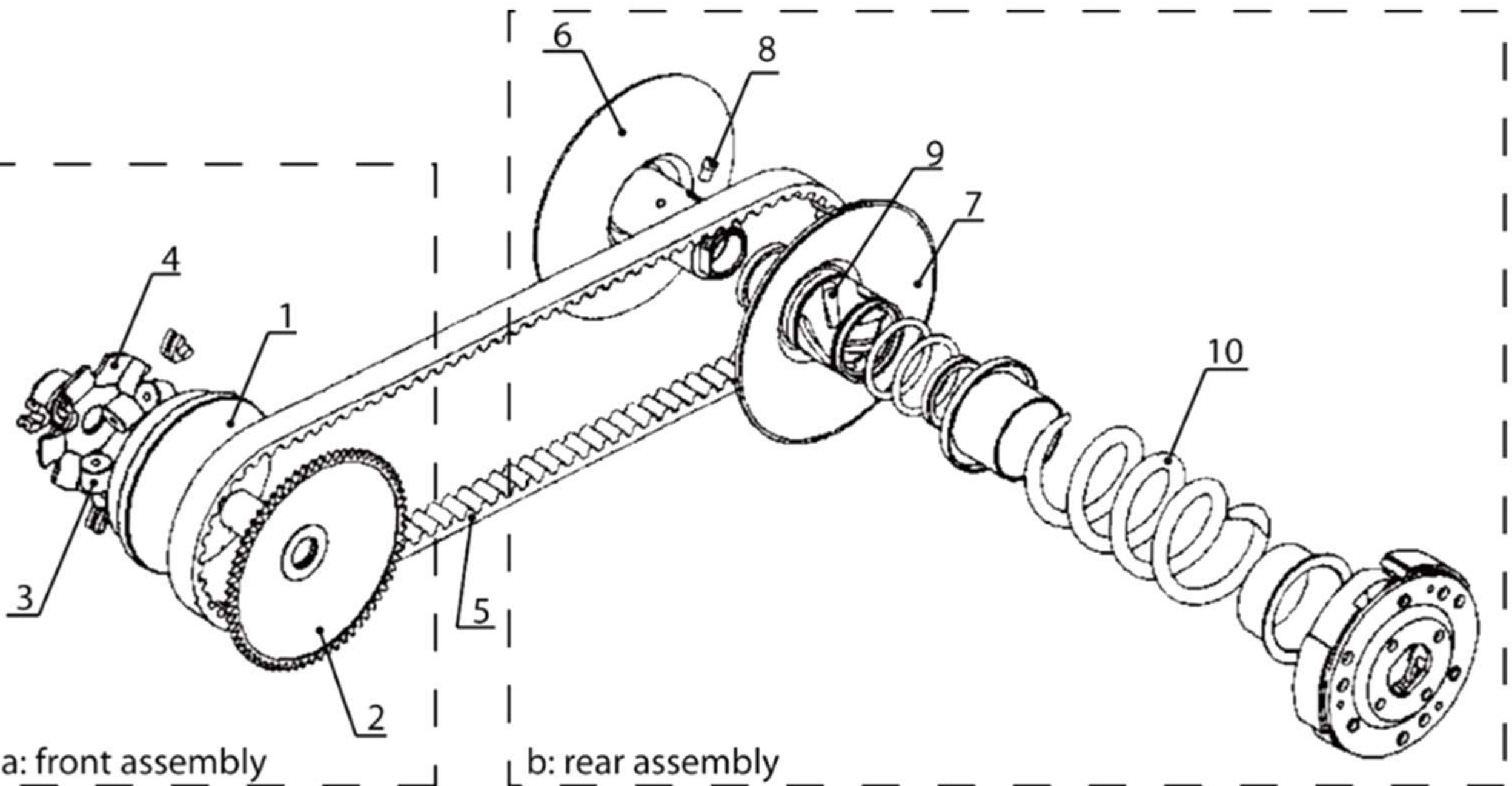


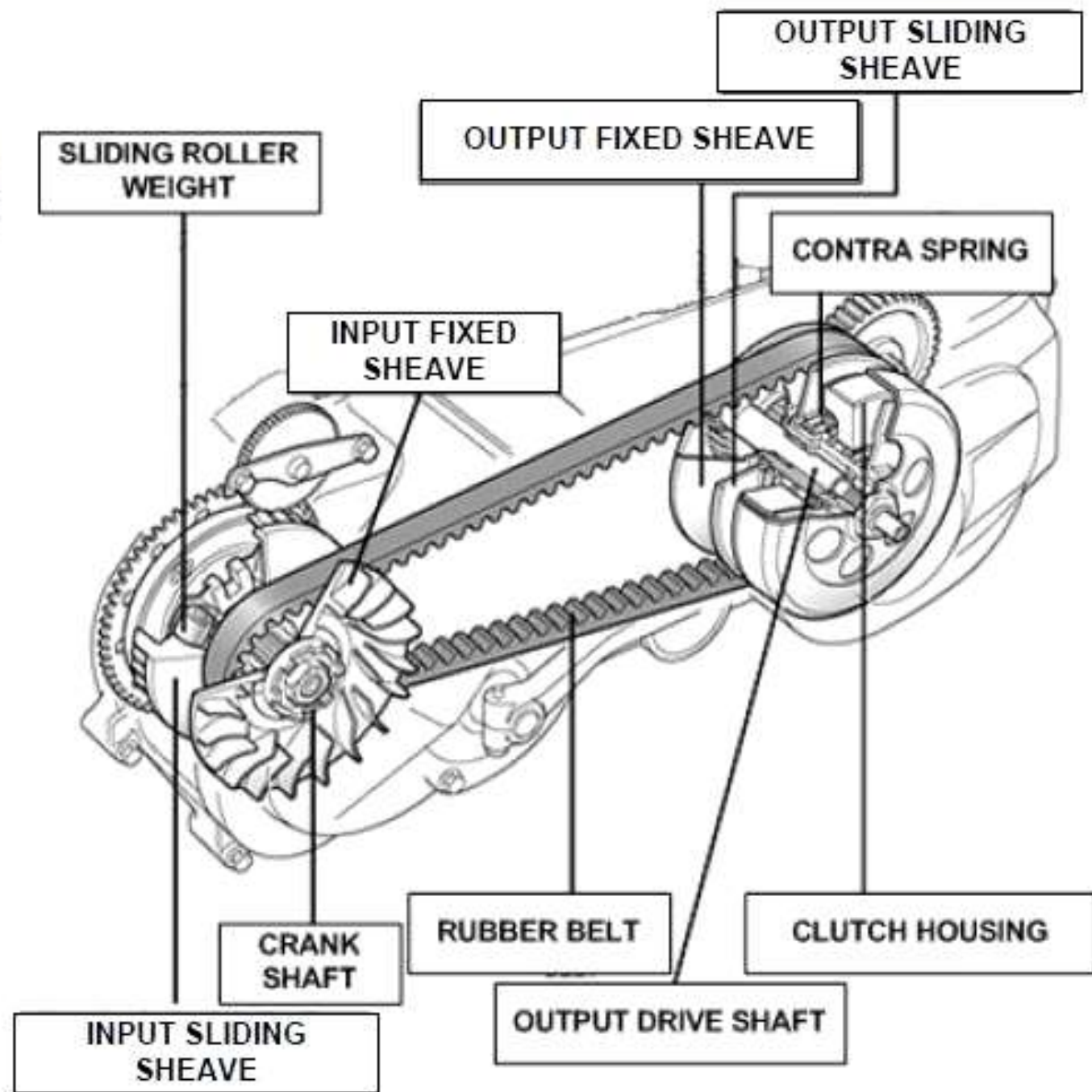
Chain Drive



- **Belt Drive** is another type of final drive. And this kind is popular for its durability, they need no lubrication and can be cleaned easily by washing. A belt drive is low noise specially when it compared to chain drive. Different motorcycle companies use belt drive Such as BMW, Indian Motorcycle and Harley Davidson.







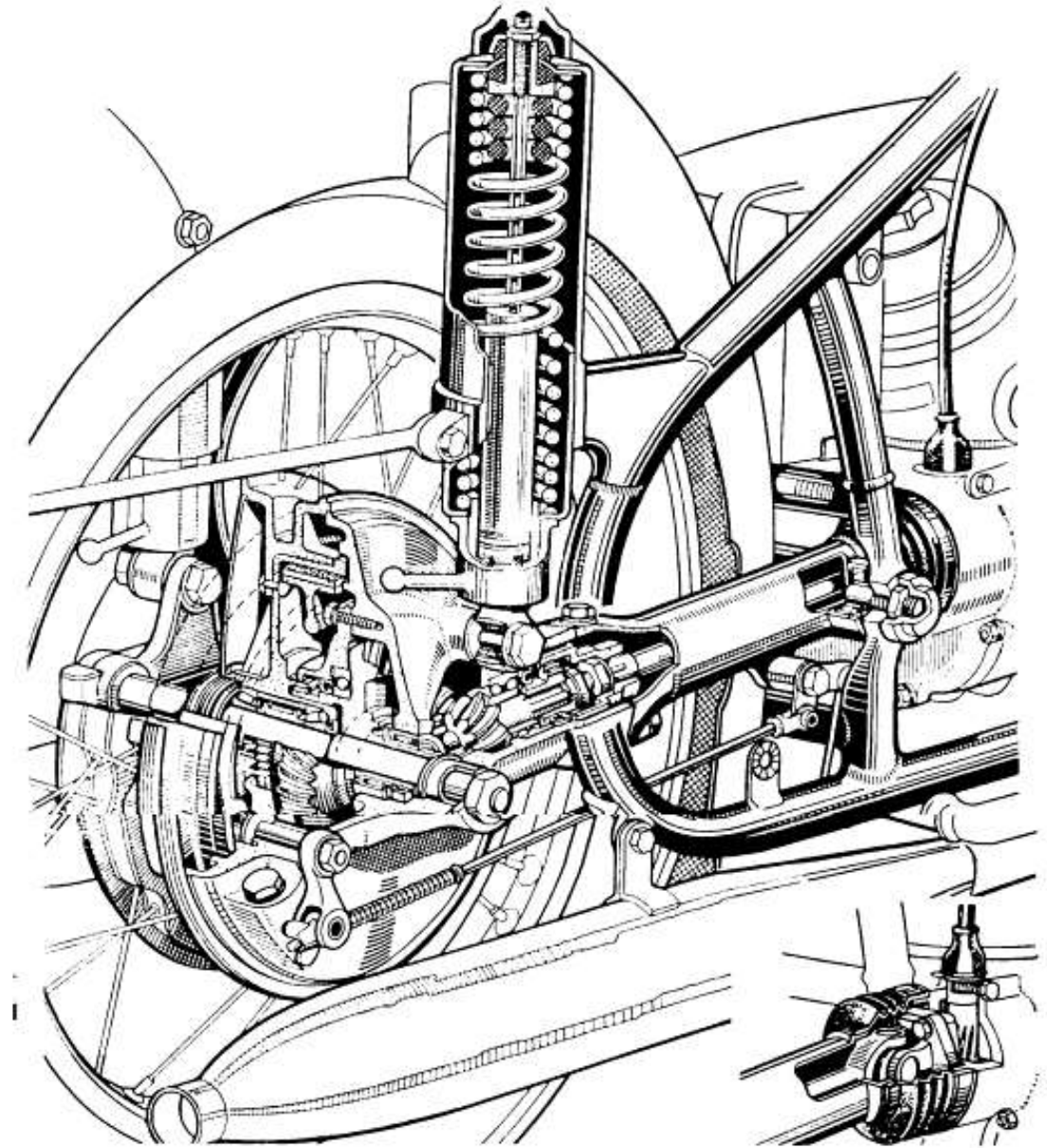
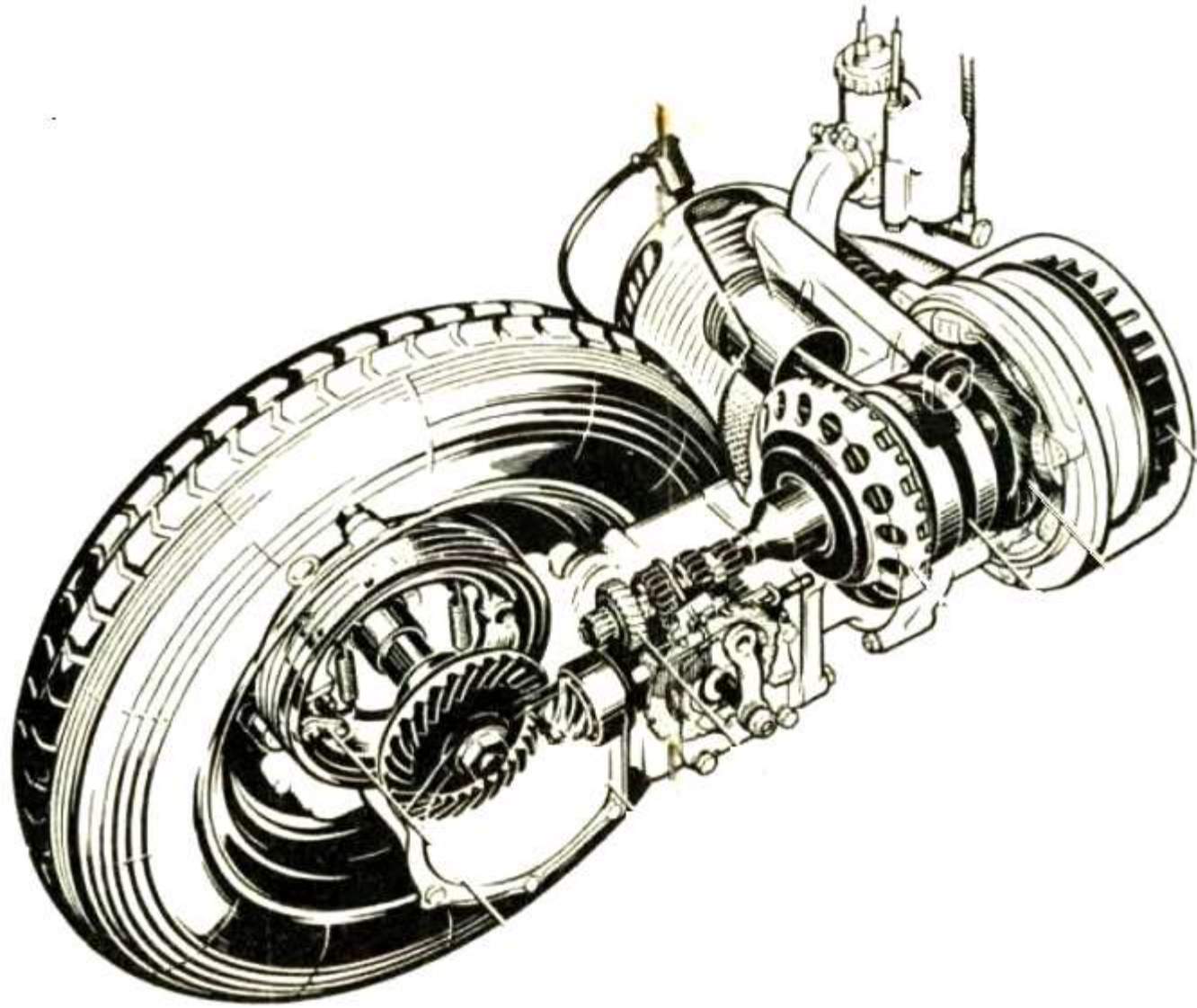
BMW F800 ST
Engine 800cc
Belt Drive



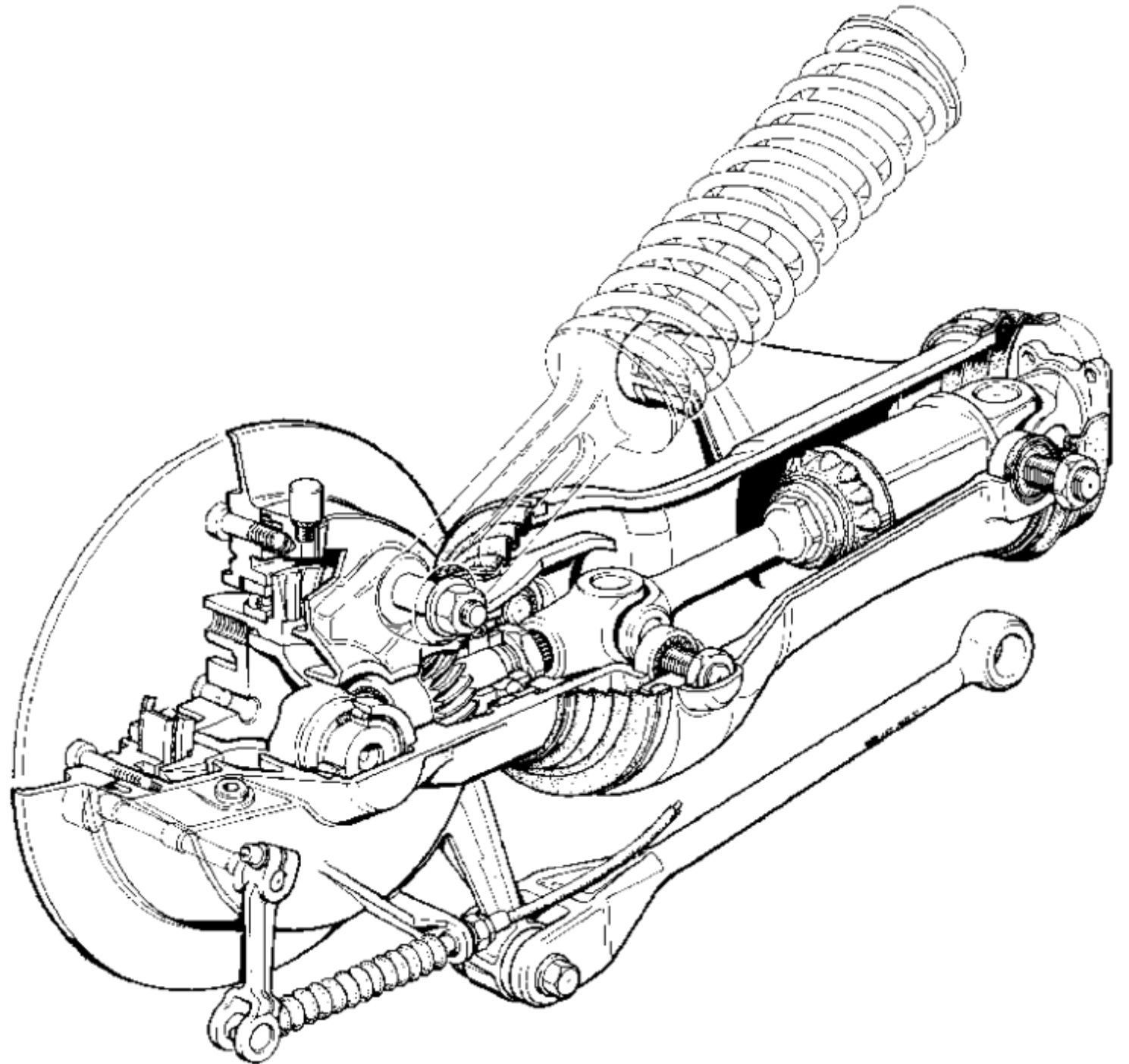
- **Shaft Drive:** The Shaft drive transmit power to rear wheel through driveshaft, using a Driveshaft from the engine to a spiral bevel gear on the rear wheel hub.



Shaft Drive Design

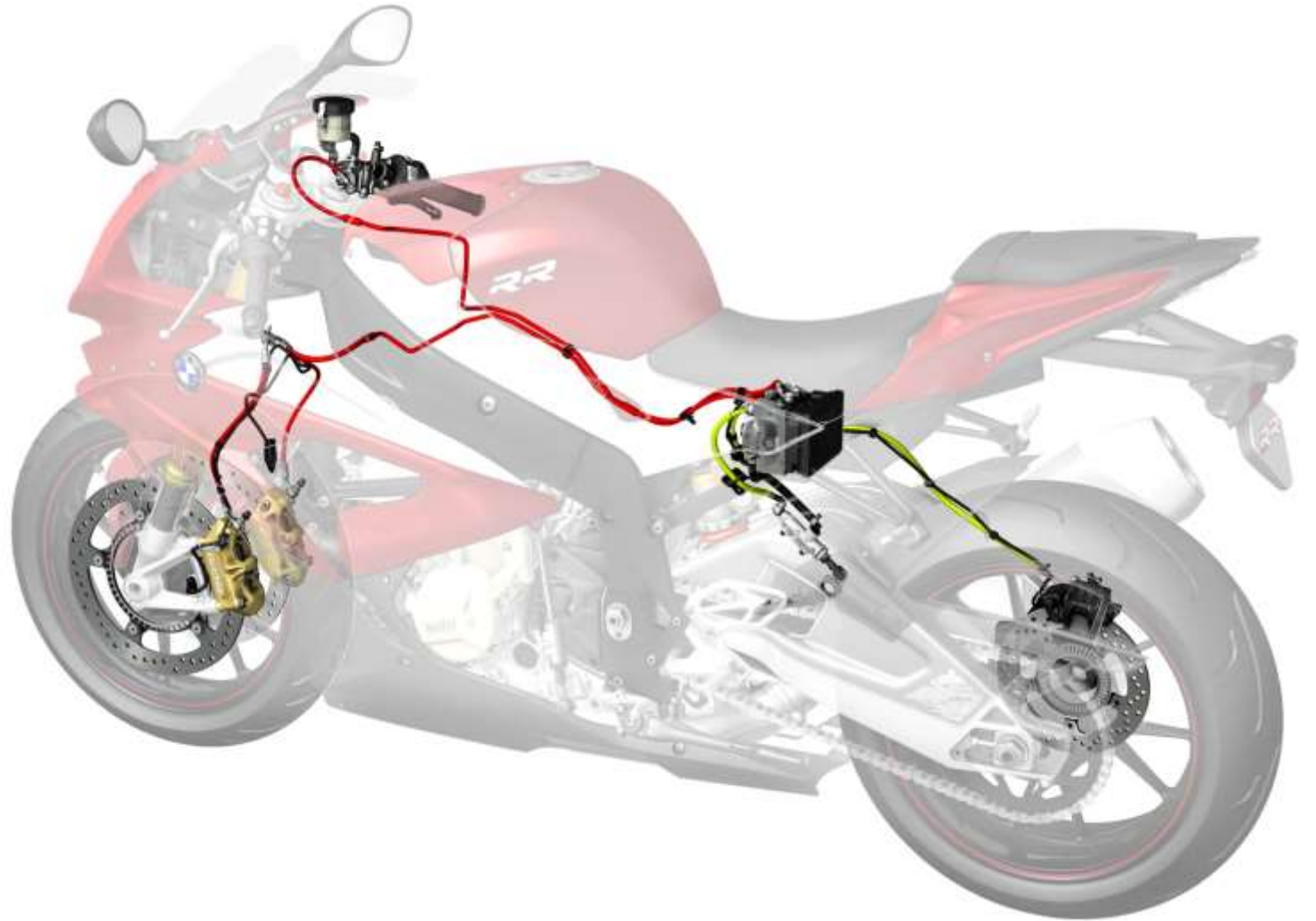


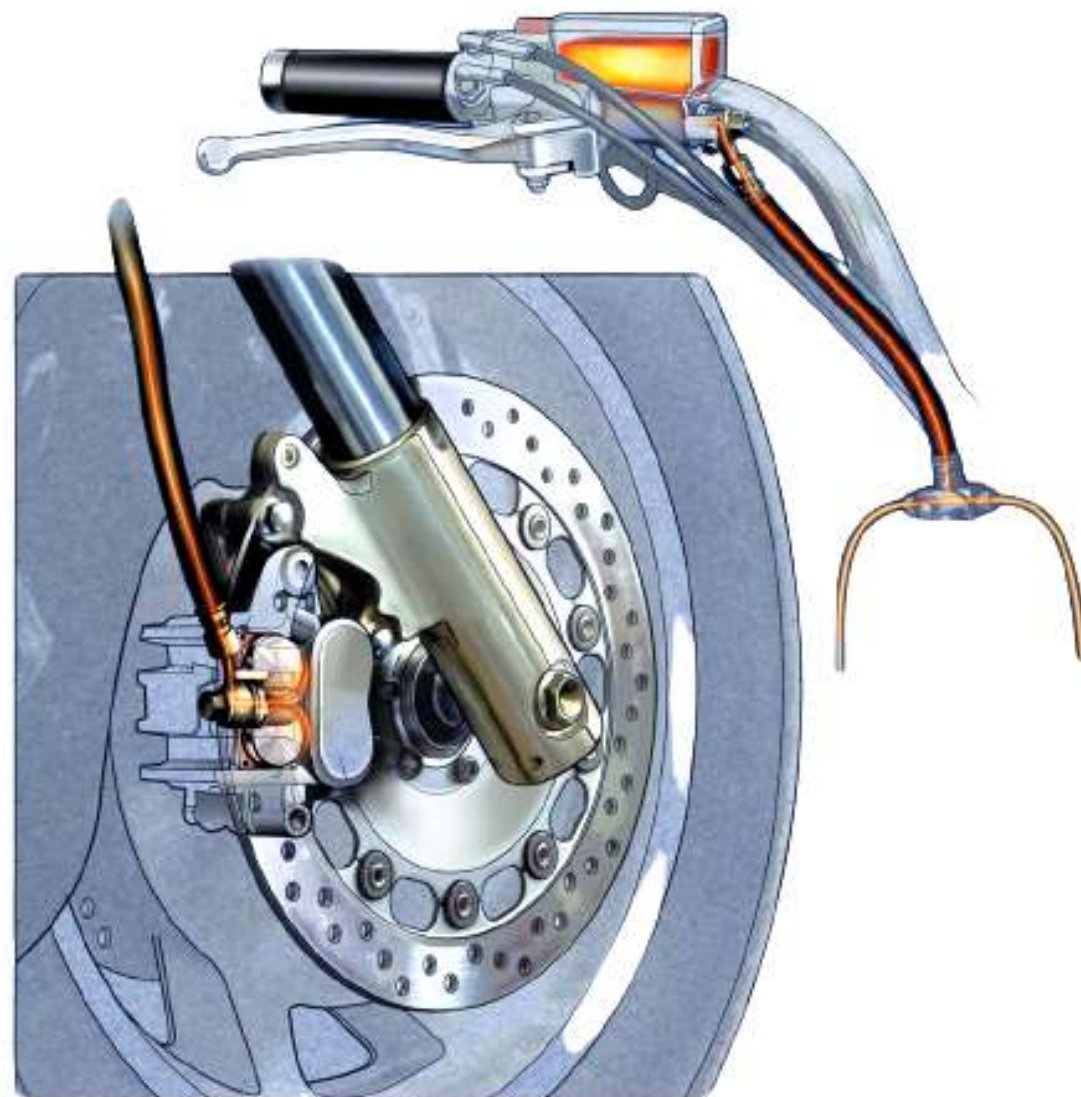
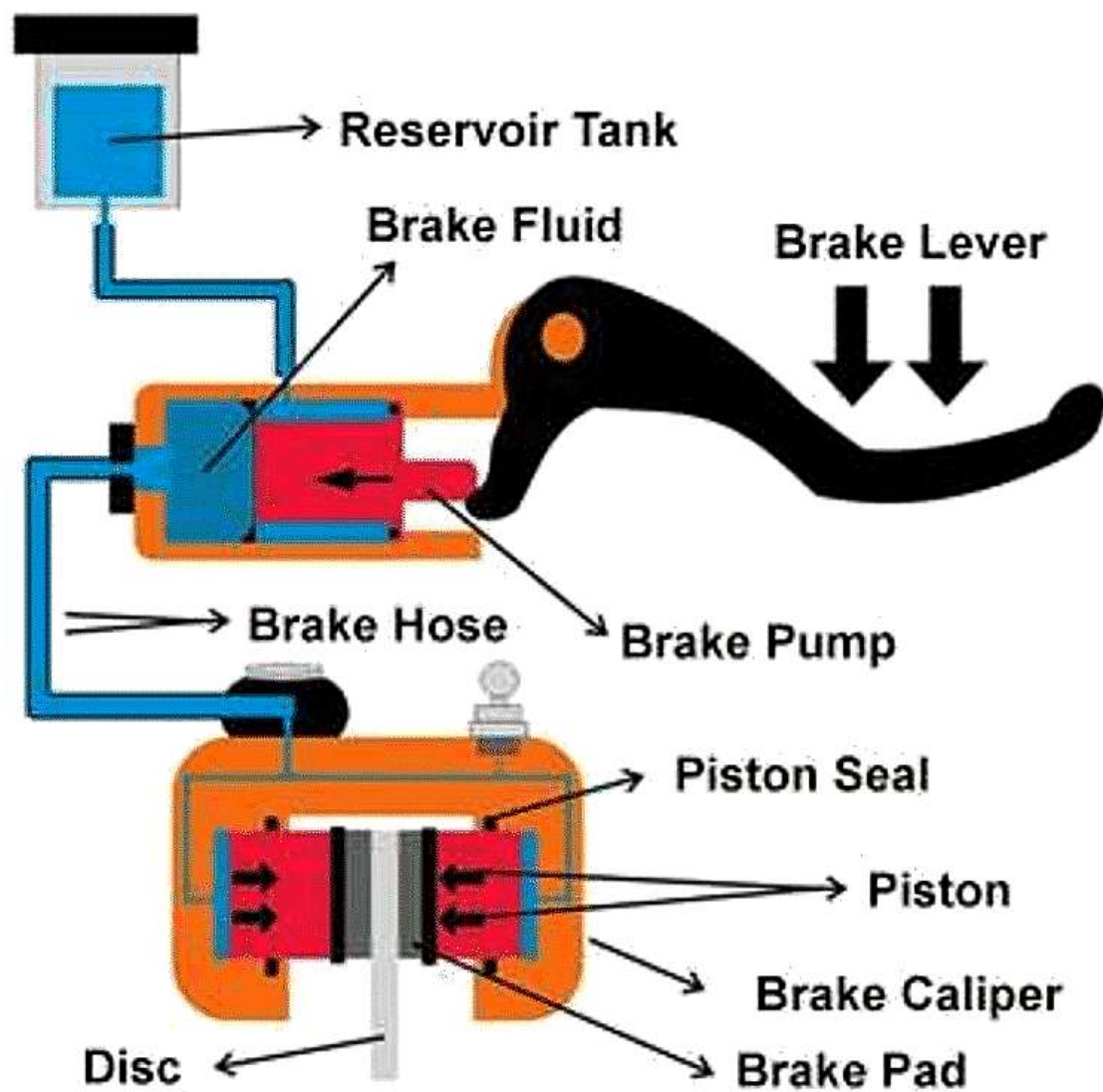
- The major benefits of **shaft-drive** are lower maintenance and running costs, Low level of noise and cleanliness. The disadvantages of chain drive bikes are that they need their chains adjusting regularly and they can be expensive to replace when they wear out



Brakes

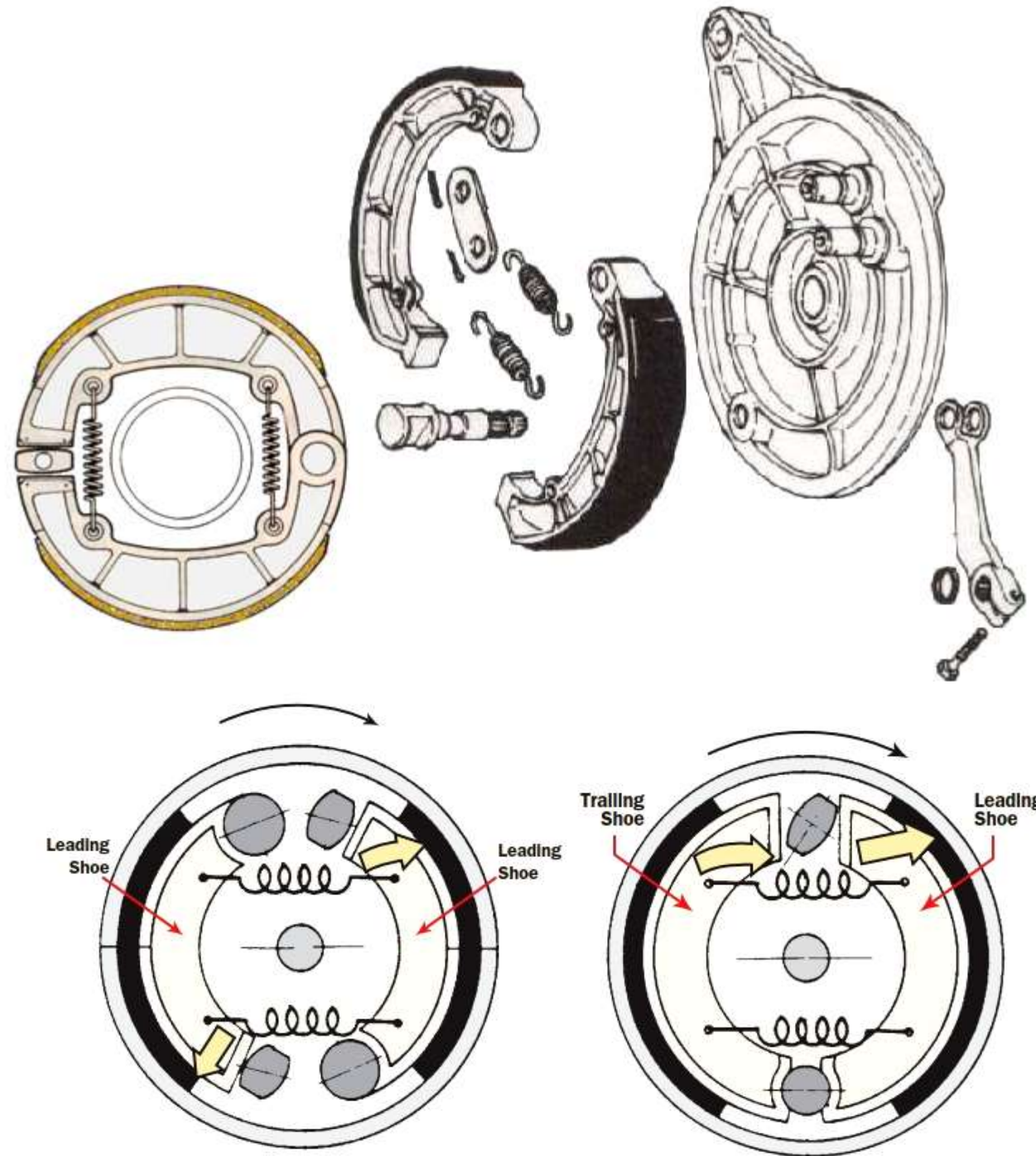
- Braking is a primary concern in the motorcycle, whether it is drum or disc brakes; both the braking systems play an important role by reducing the speed of the vehicle. Thus, the powerful braking systems are essentially used in the cars and supersports motorcycles. The brakes are working on the algorithm of energy type, which generate a friction in the respect of energy.





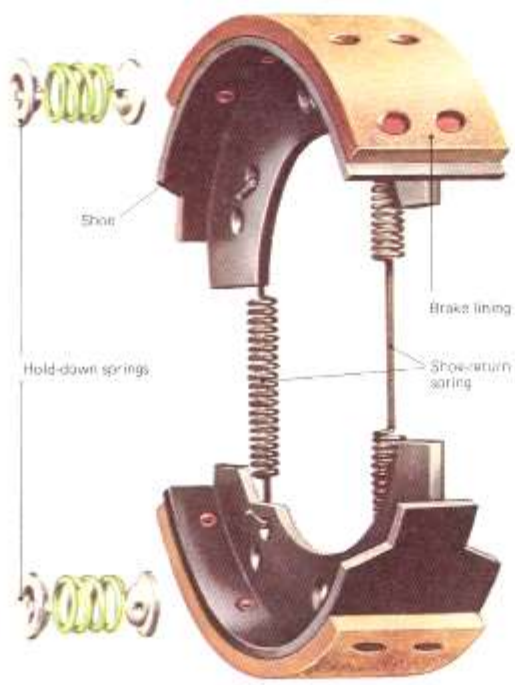
- **Drum Brakes**

The drum brake is a traditional type of braking system, which is used in many commuter motorcycles and scooters. The drum brake has two semi-circular brake shoes that are located in a drum in the wheel hub and has a piston. When you applied the front and rear brake then the piston pushes the brake shoes against the drum.





Brake drum

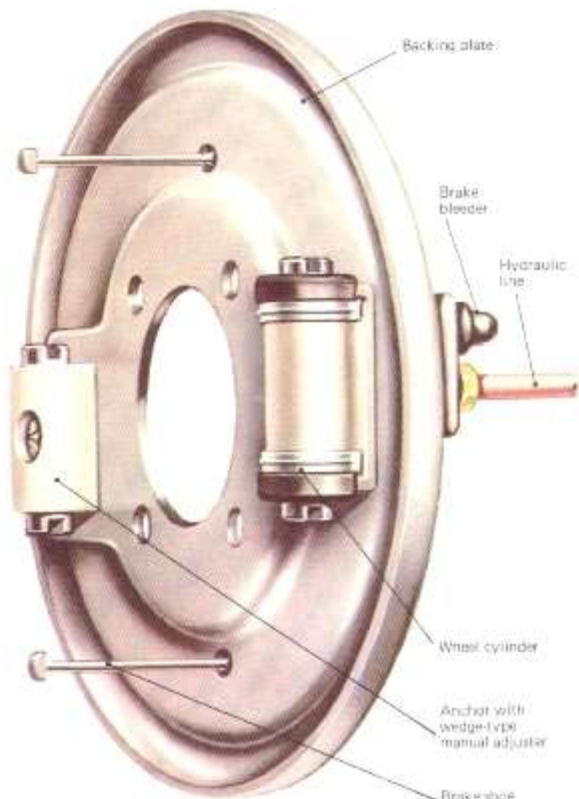


Shoe

Hold-down springs

Brake lining

Shoe return spring



Backing plate

Brake bleeder

Hydraulic line

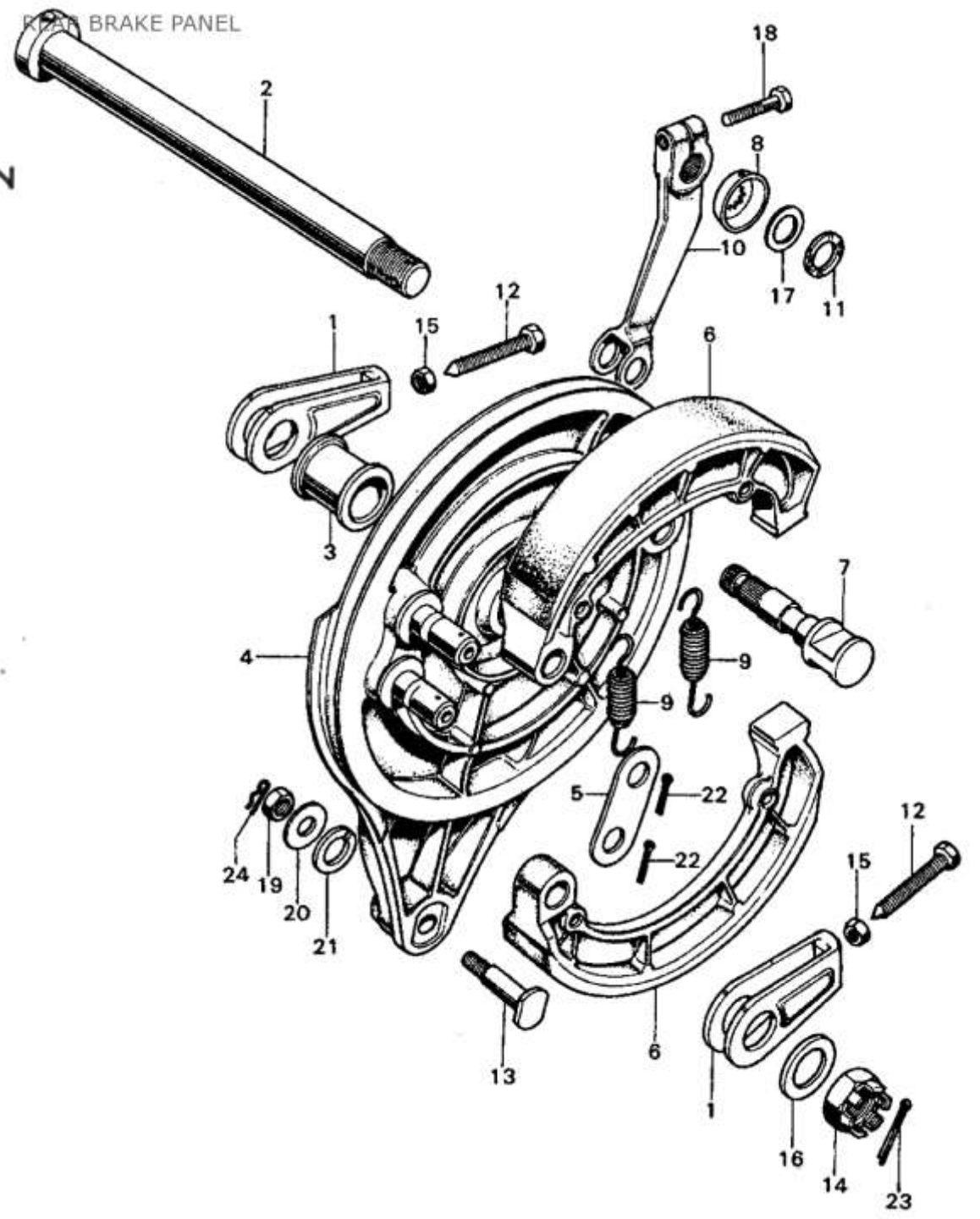
Wheel cylinder

Anchor with wedge-type manual adjuster

Brake shoe hold-down pin



REAR BRAKE PANEL



BRAKE SHOE

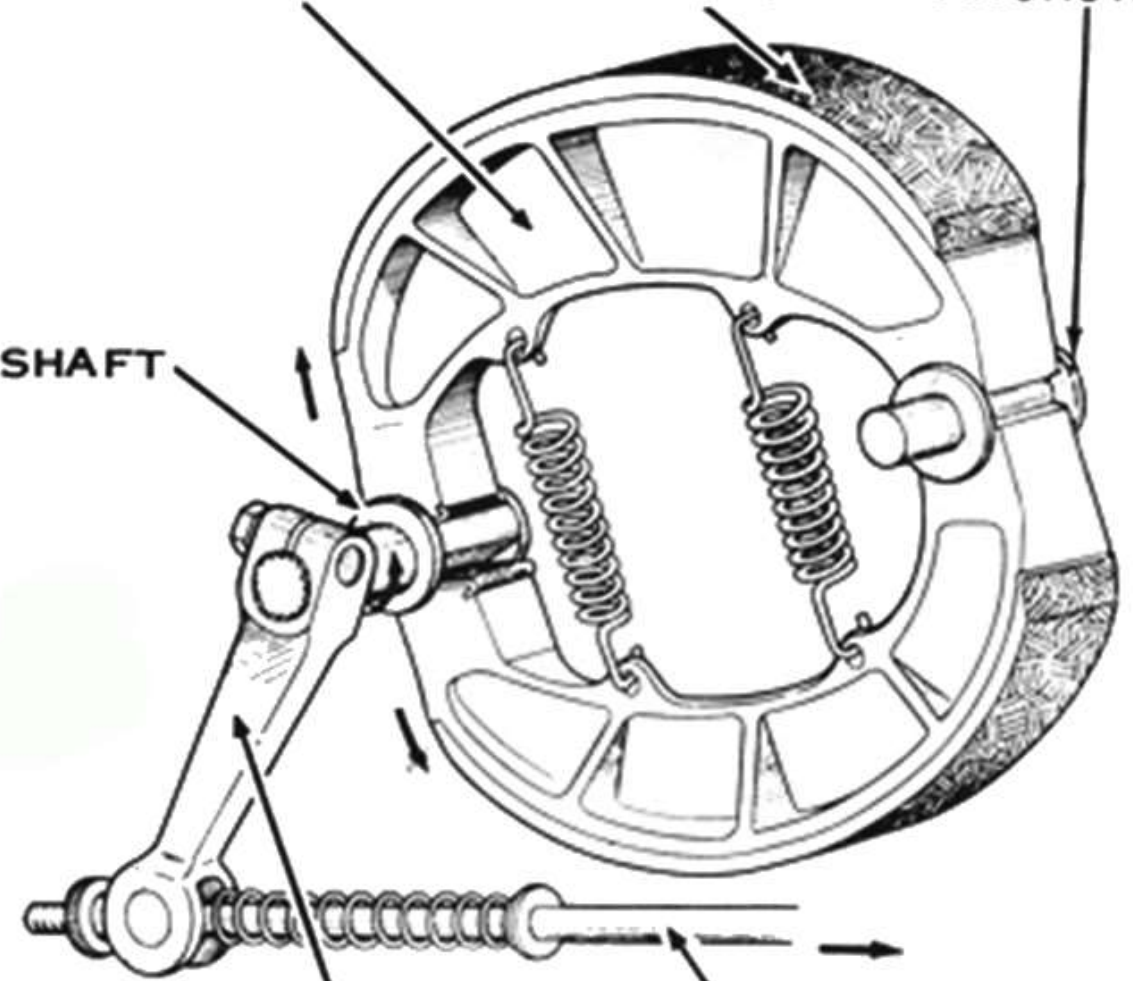
LINING

ANCHOR PIN

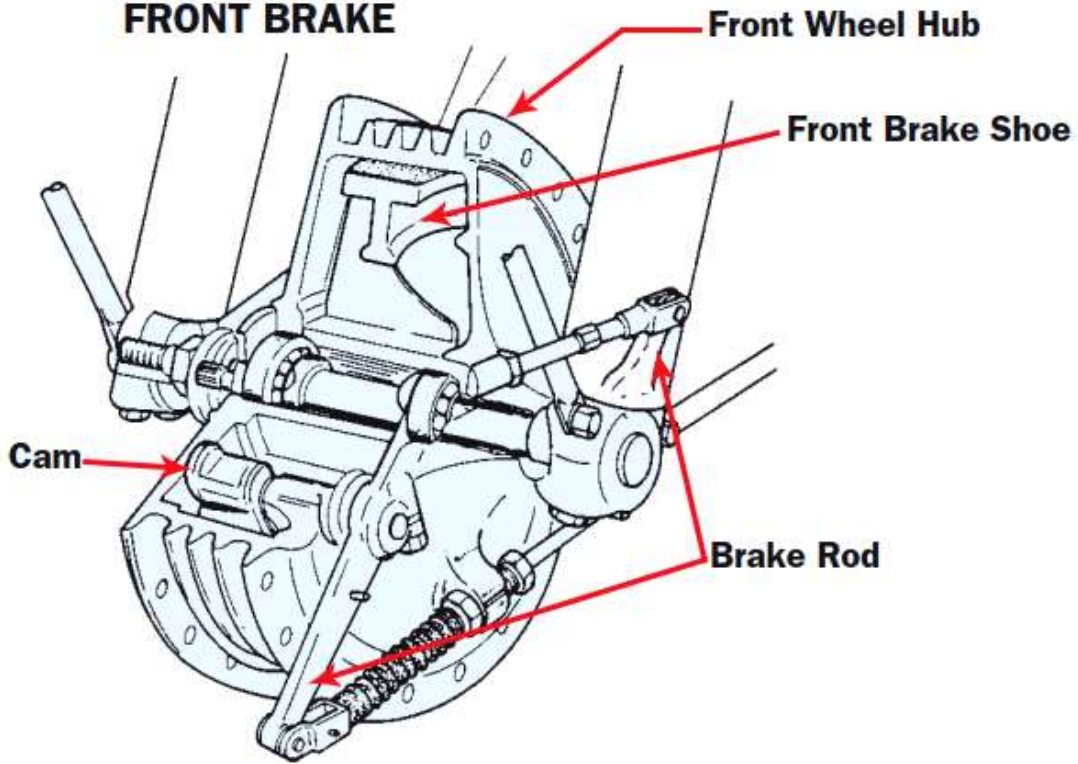
CAMSHAFT

ACTUATING LEVER

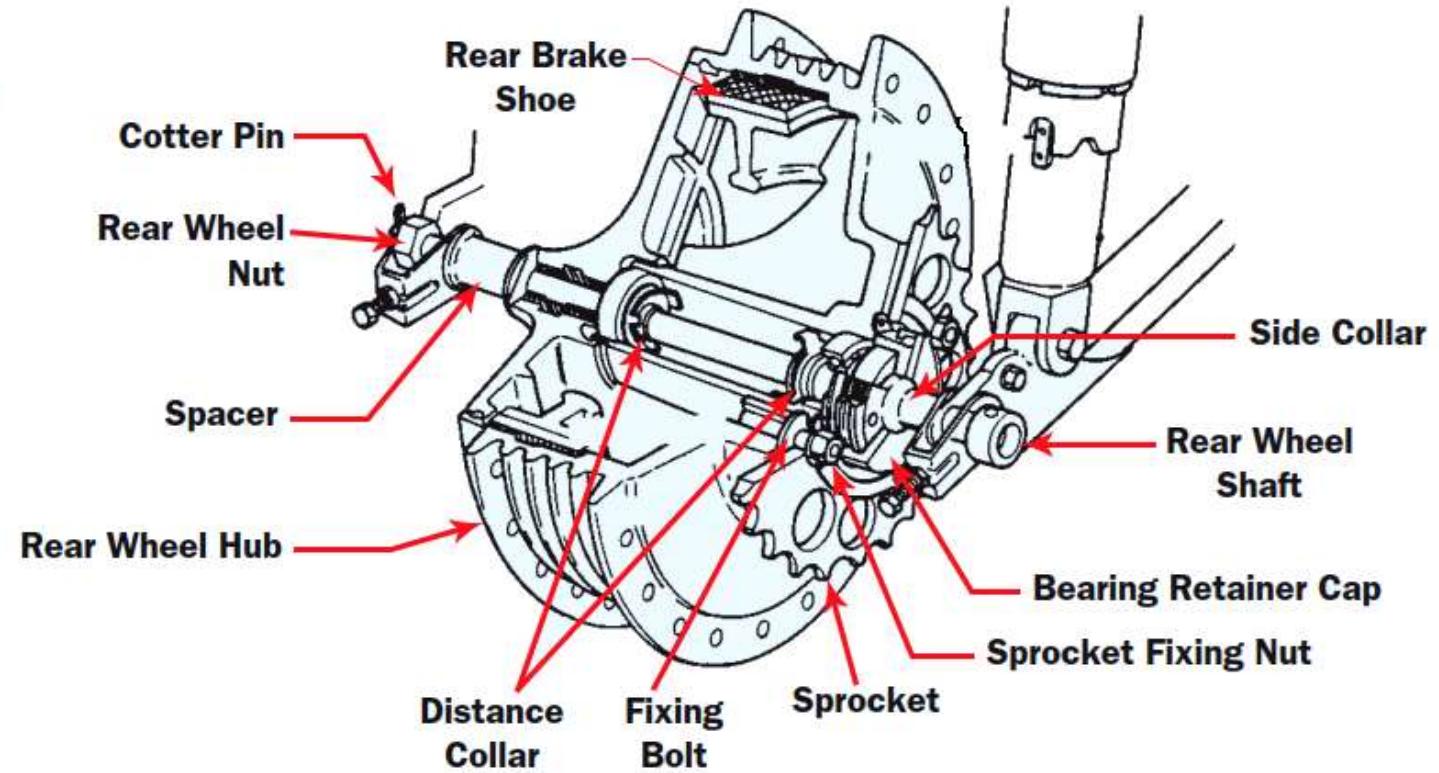
ACTUATING ROD



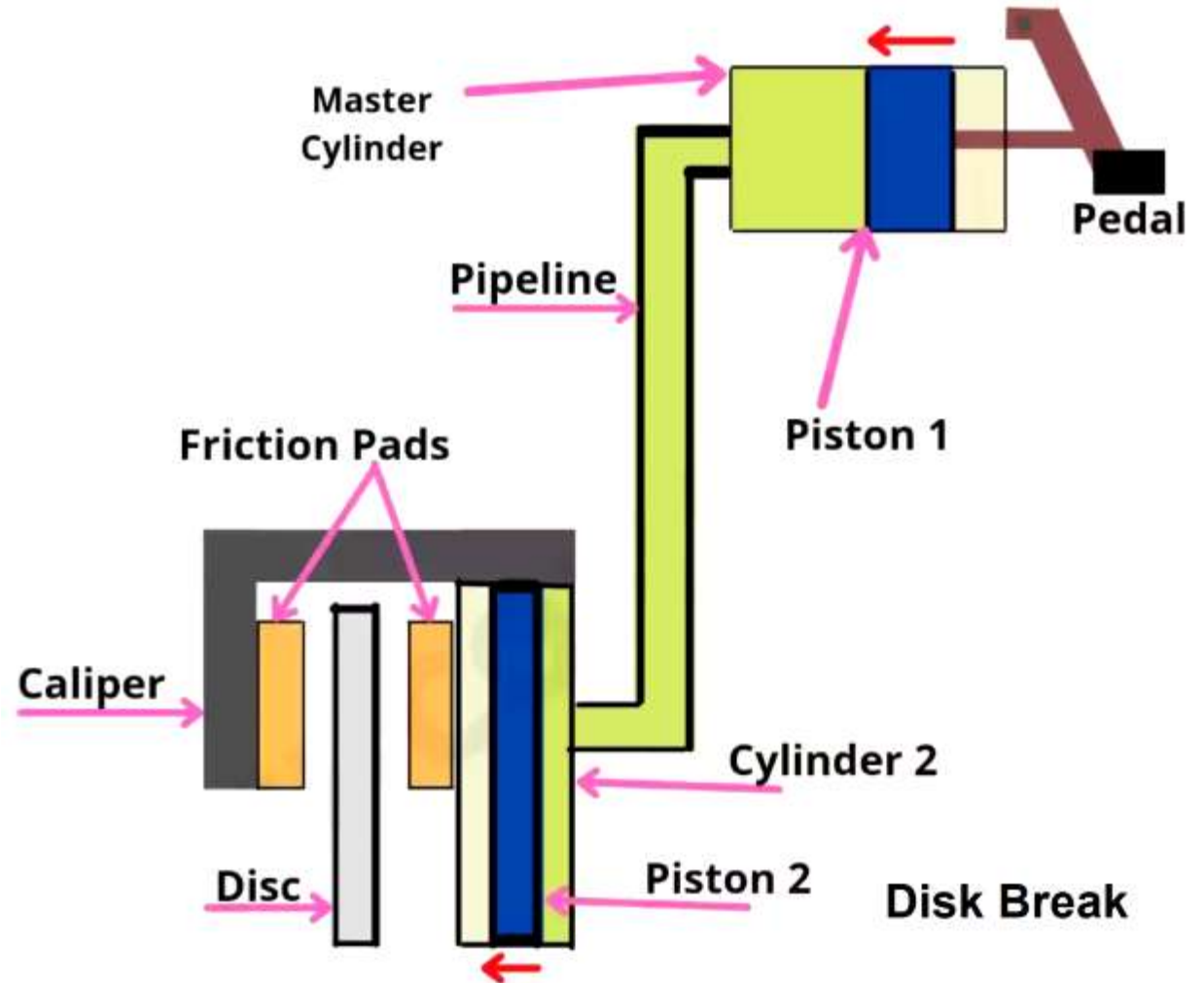
FRONT BRAKE

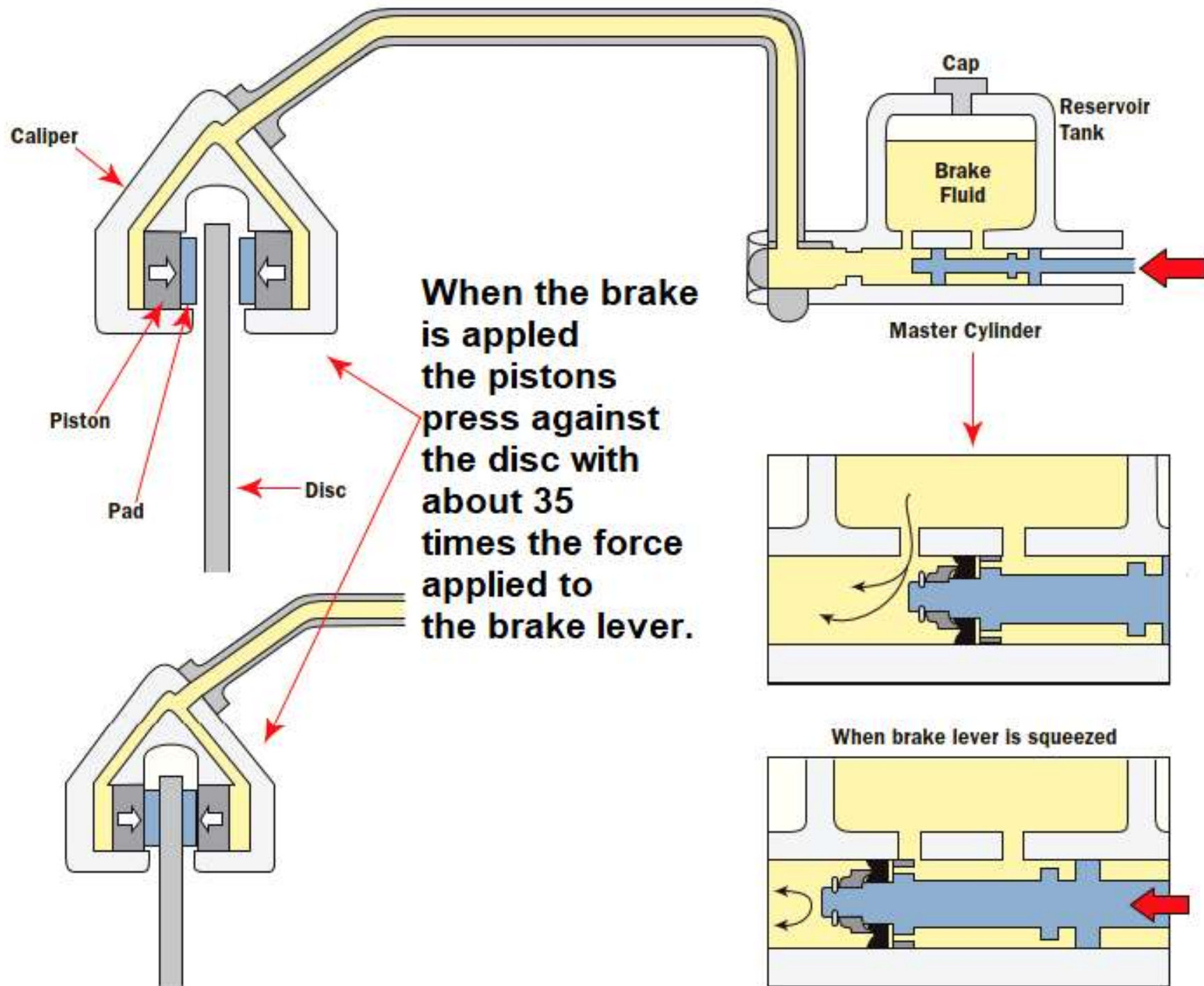


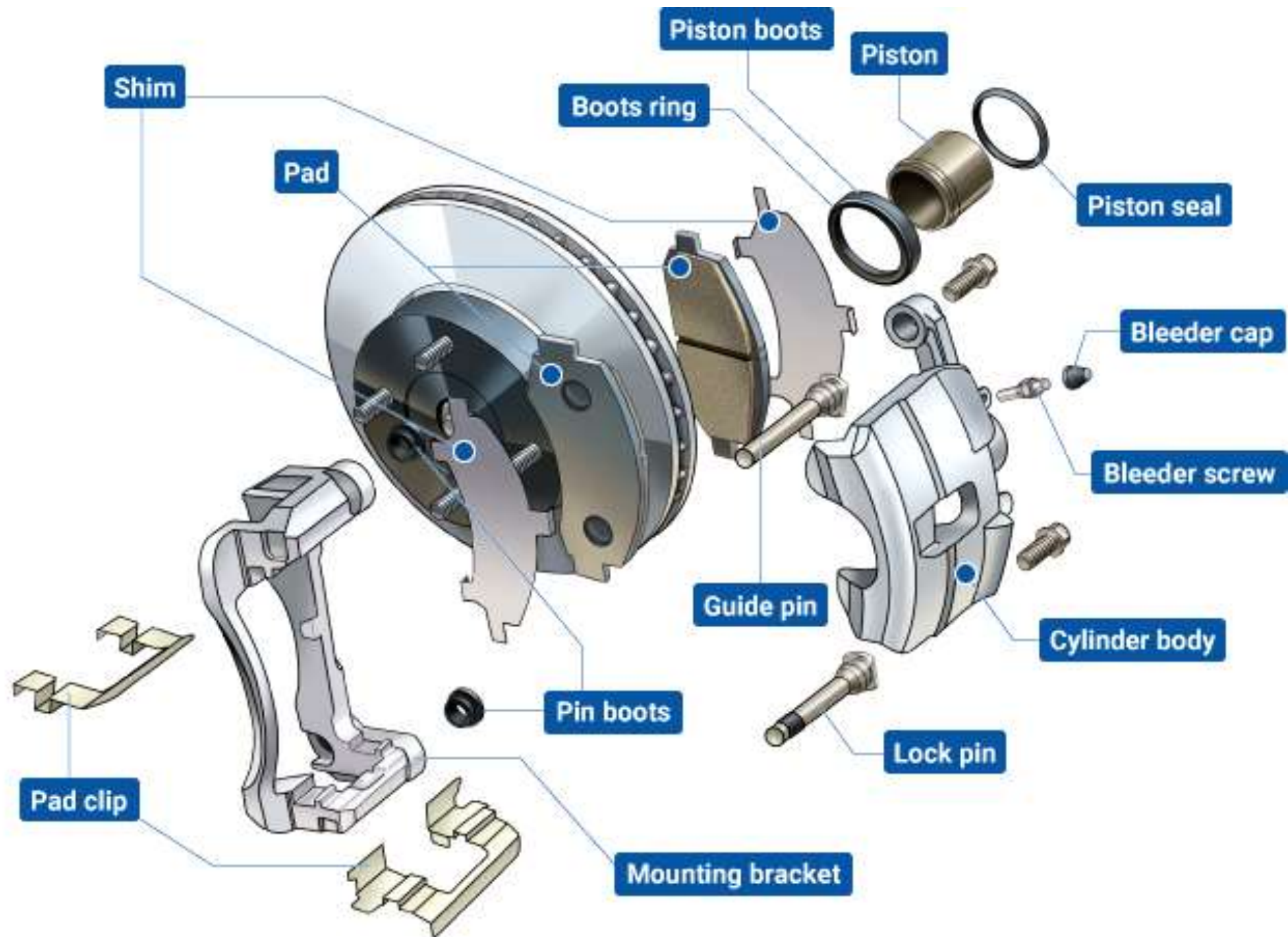
REAR BRAKE



- **Disk Brakes** A disc brake is a type of brake that uses the calipers to squeeze pairs of pads against a disc or a "rotor" to create friction. This action slows the rotation of a shaft, such as a vehicle axle, either to reduce its rotational speed or to hold it stationary

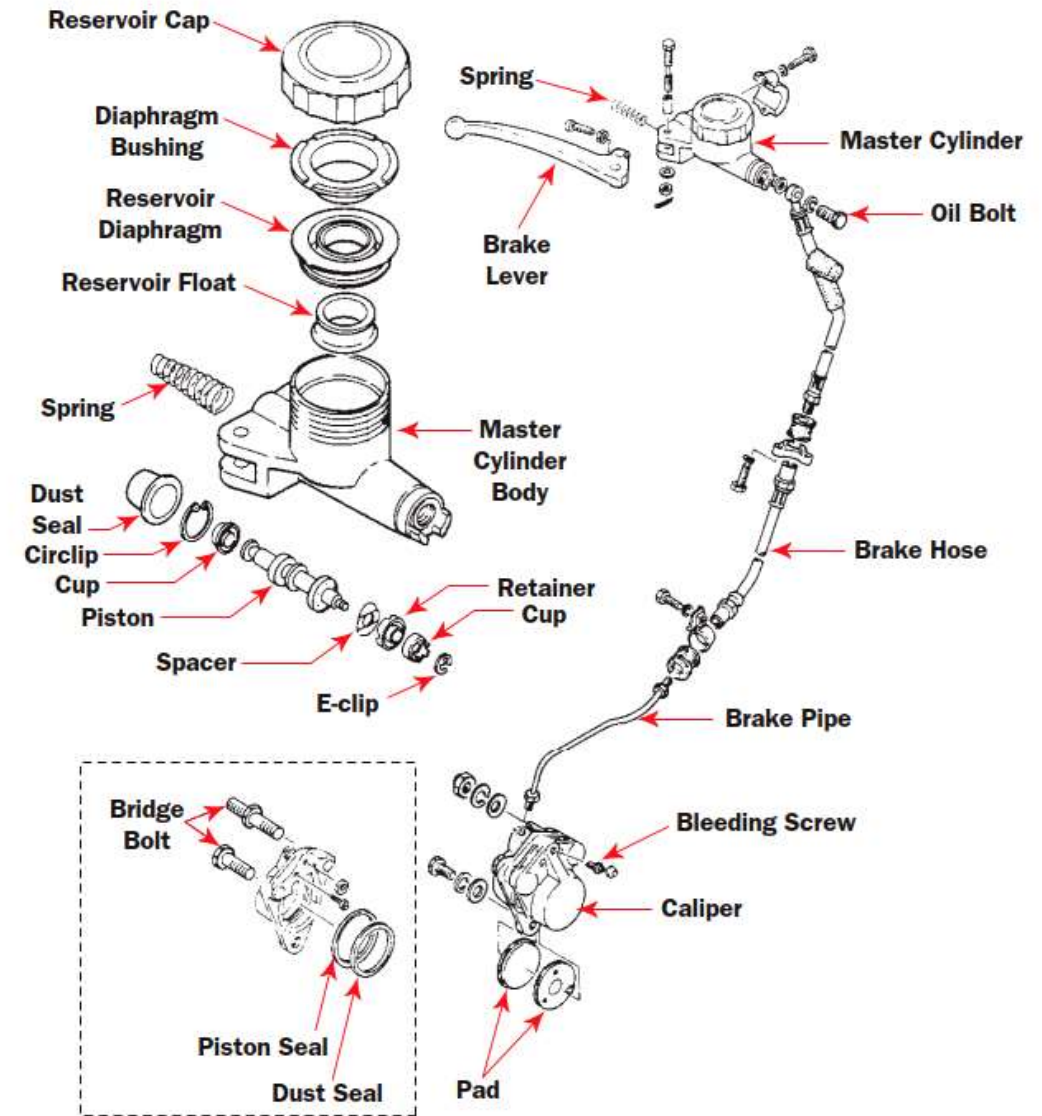


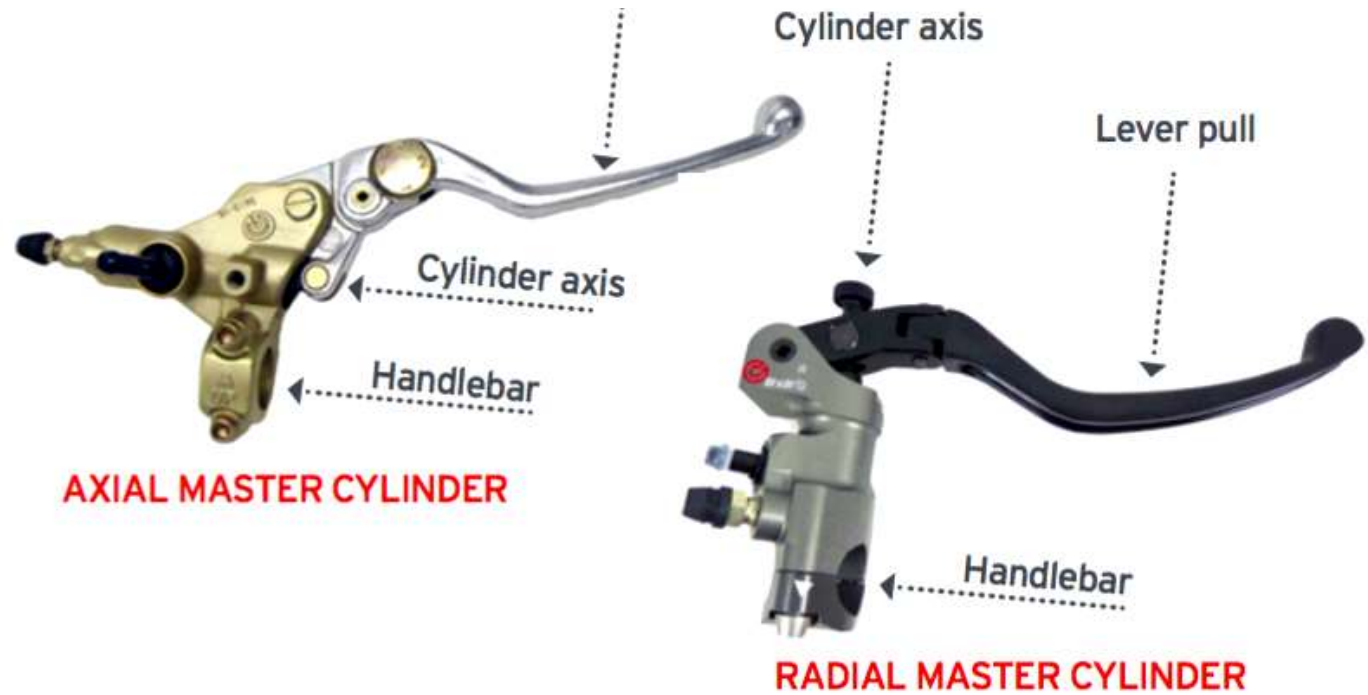
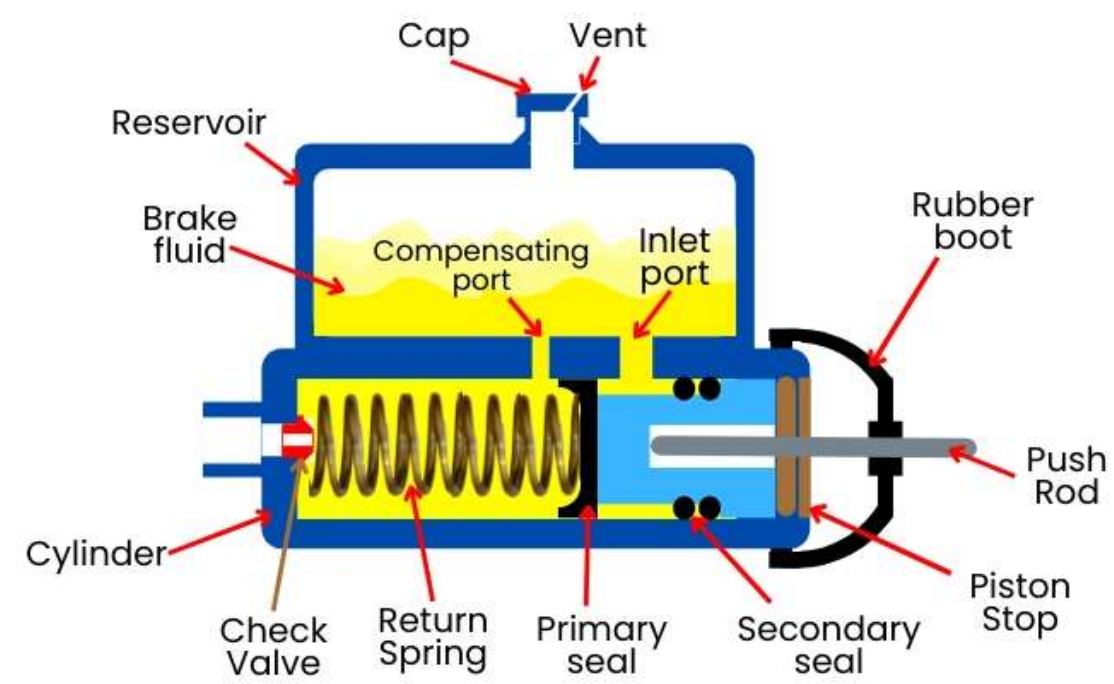
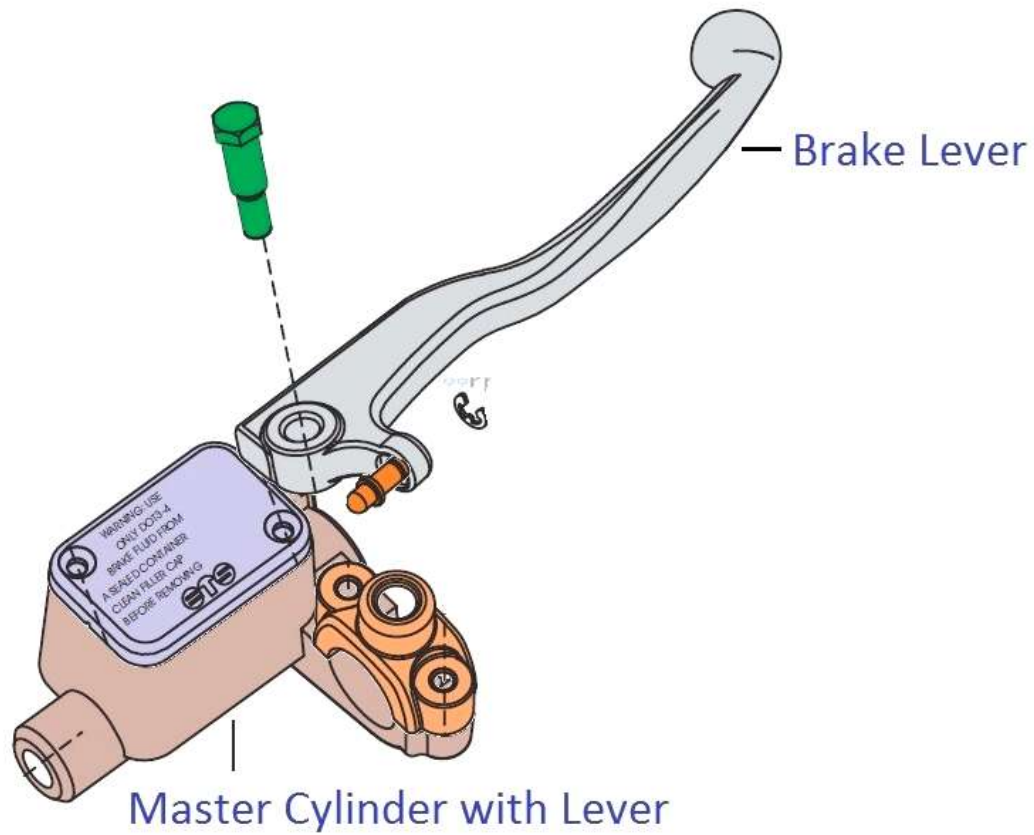


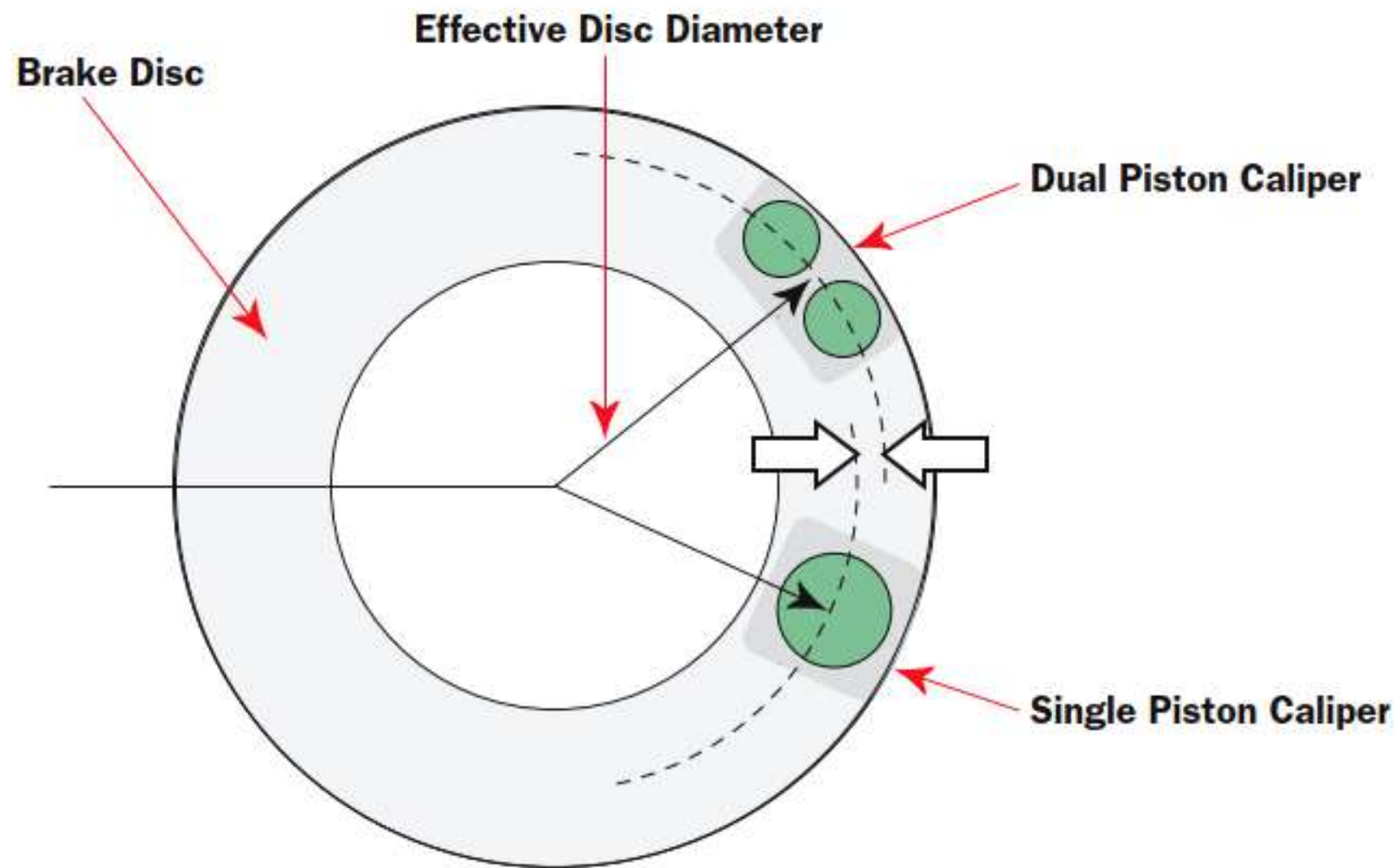




The brake lever and master cylinder are installed on the right side of the handlebar. The caliper assembly, having a pair of pistons and pads, is secured to the front forks. The disc is directly connected to the front hub. The master cylinder is linked to the caliper by means of the brake hose and pipe, through which the brake fluid is forced.



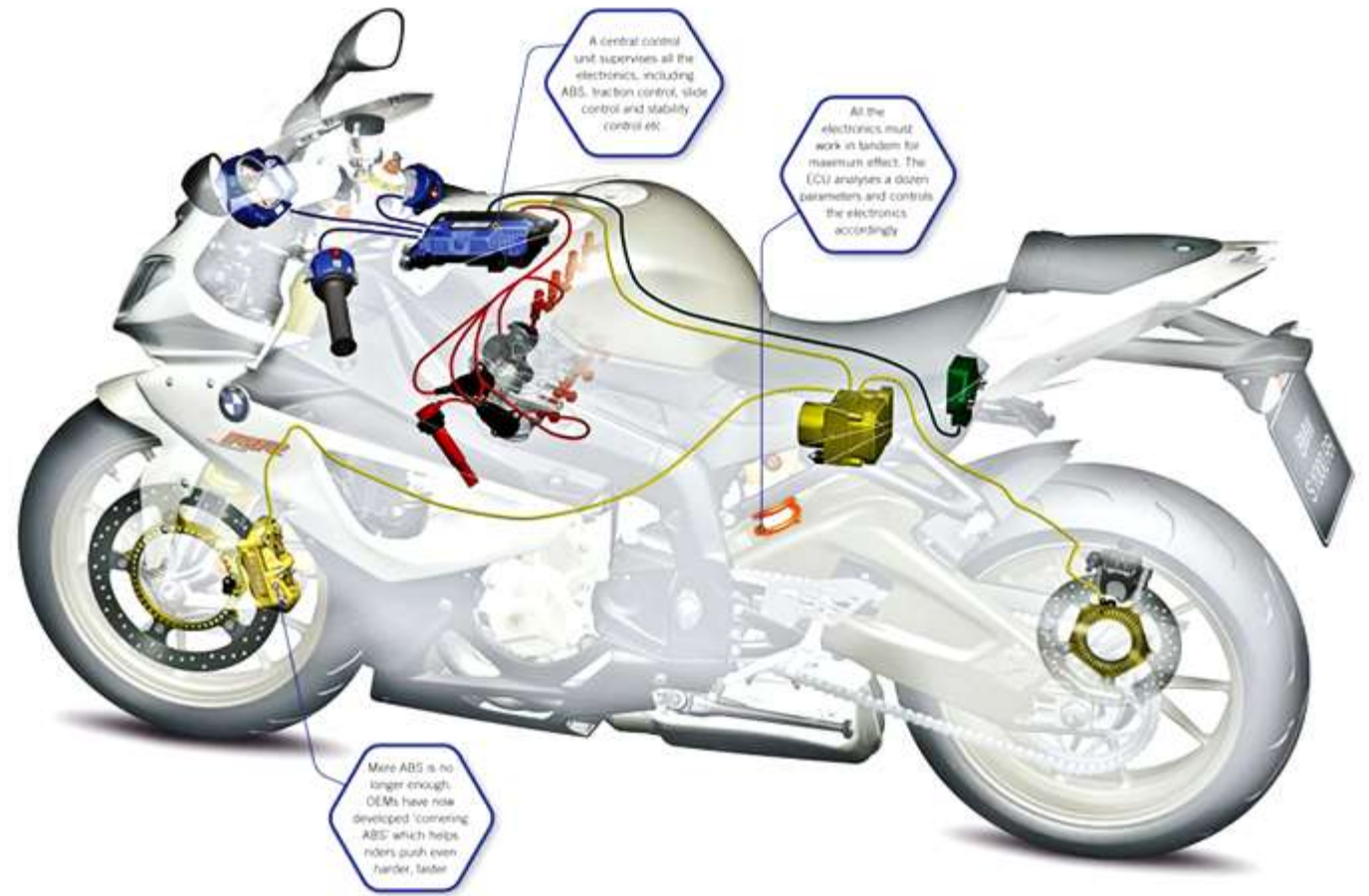




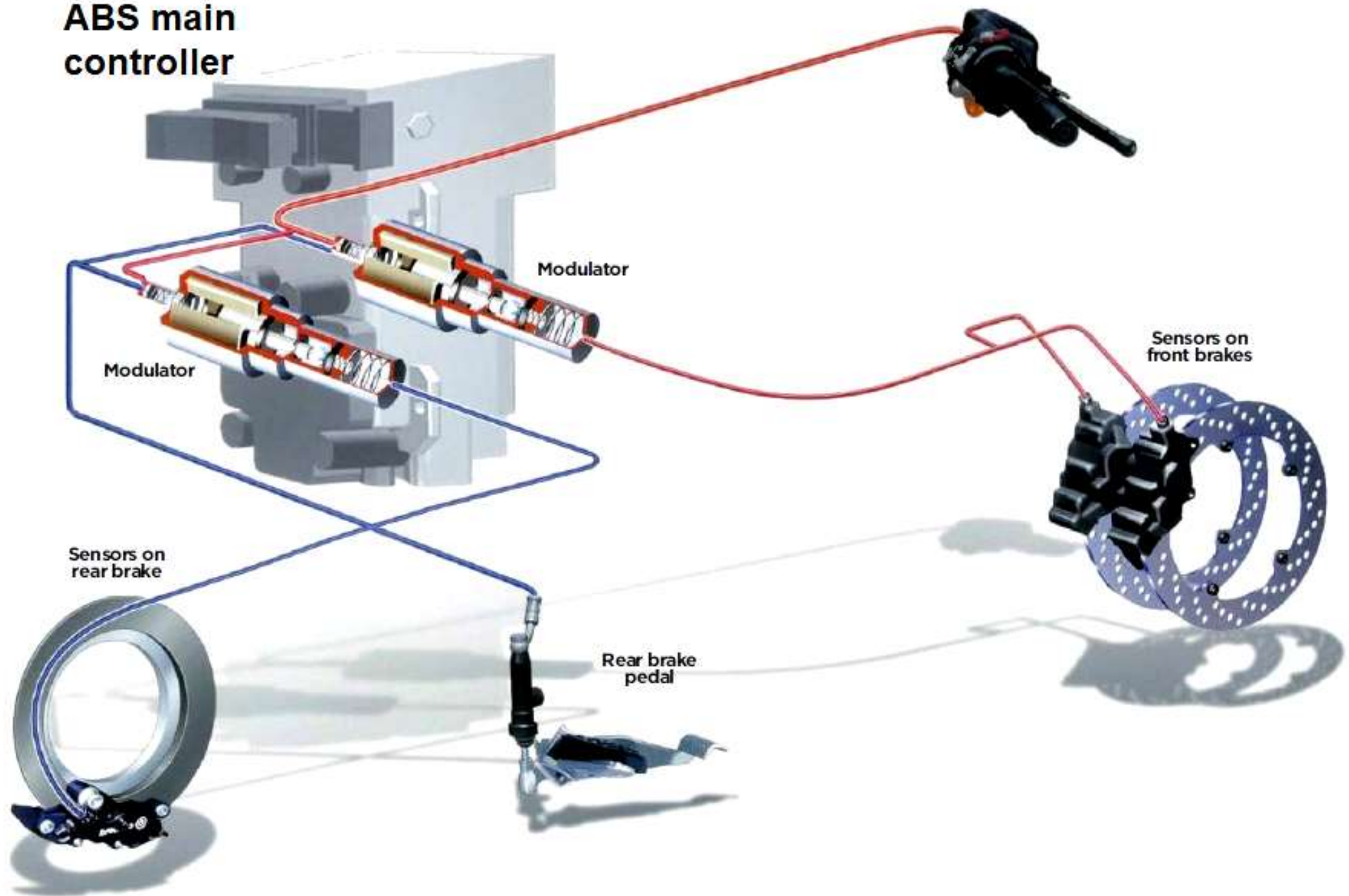
Dual Piston Caliper



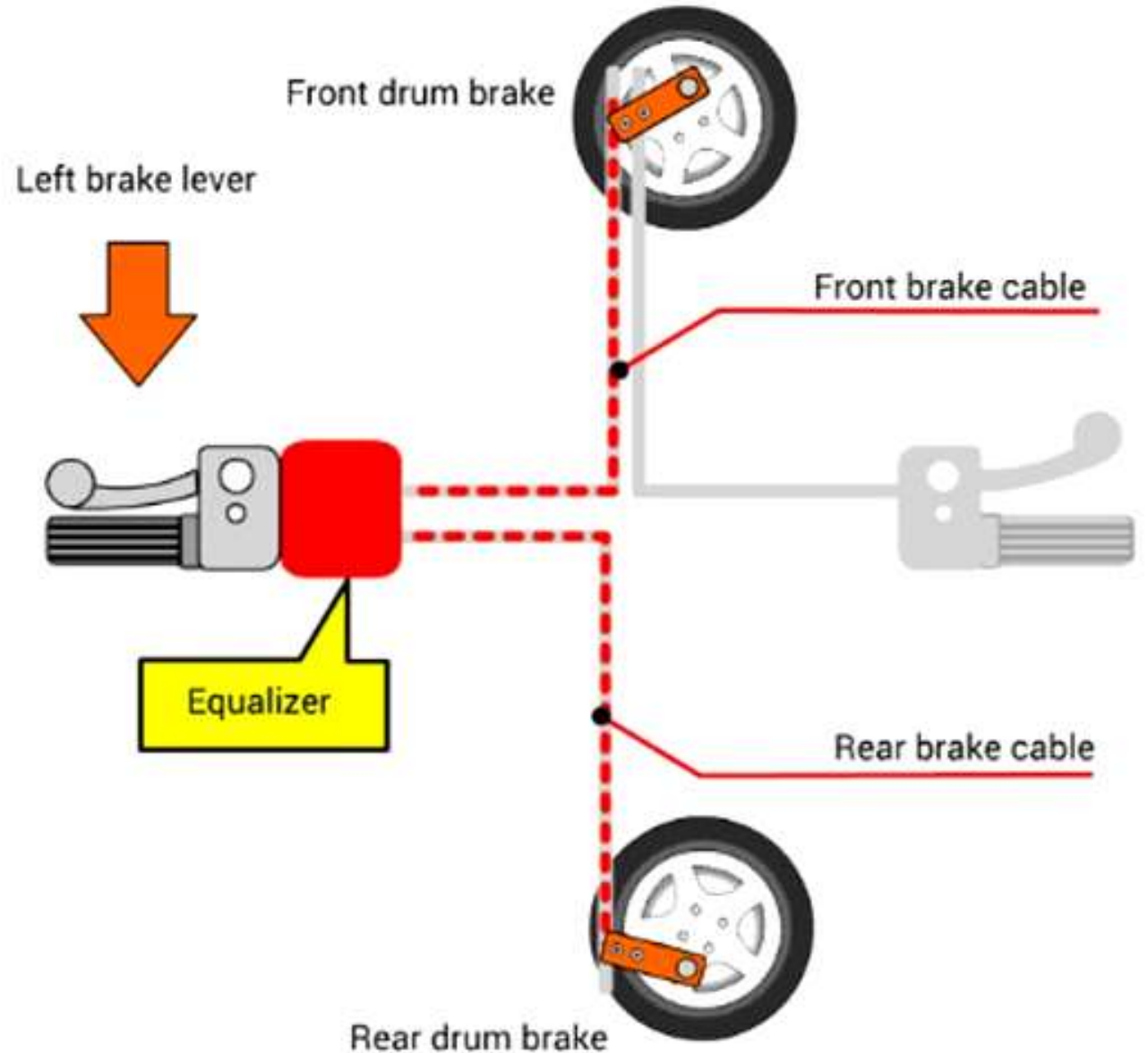
- **Anti-Lock Brakes (ABS)** The Anti-lock braking system is an innovative technology that allows the wheel to maintain tractive contact with the any kind of road surface. The anti-lock braking system is used for preventing the wheel to get locked under the hardest braking.

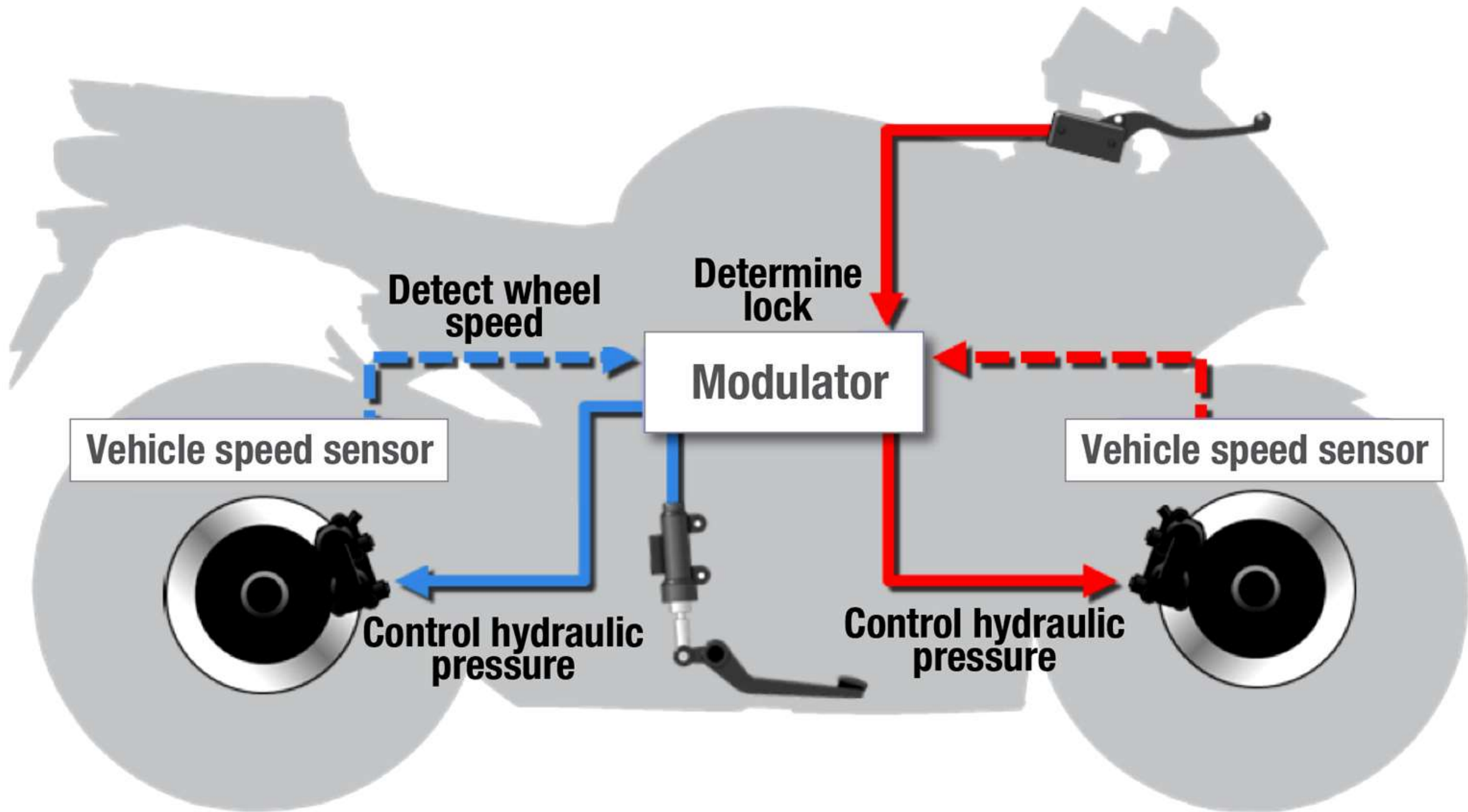


ABS main controller

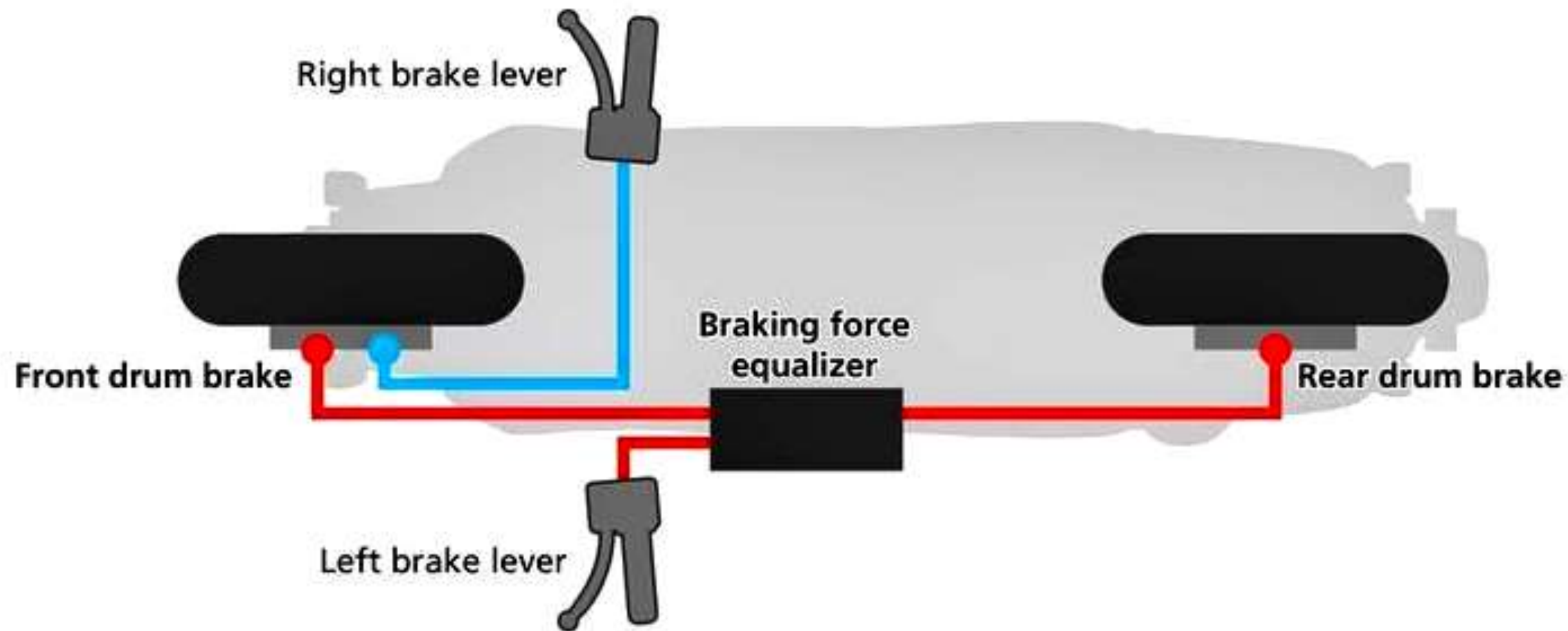


- **Integrated Brakes:**
A combined braking system (CBS), also called **linked braking system (LBS)**, is a system for linking front and rear brakes on a motorcycle or scooter. In this system, the rider's action of depressing one of the brake levers applies both front and rear brakes. The amount of each brake applied may be determined by a proportional control valve. This is distinct from (conventional) integrated brakes, where applying pressure to the rear brake pedal only applies some braking force to the front brake

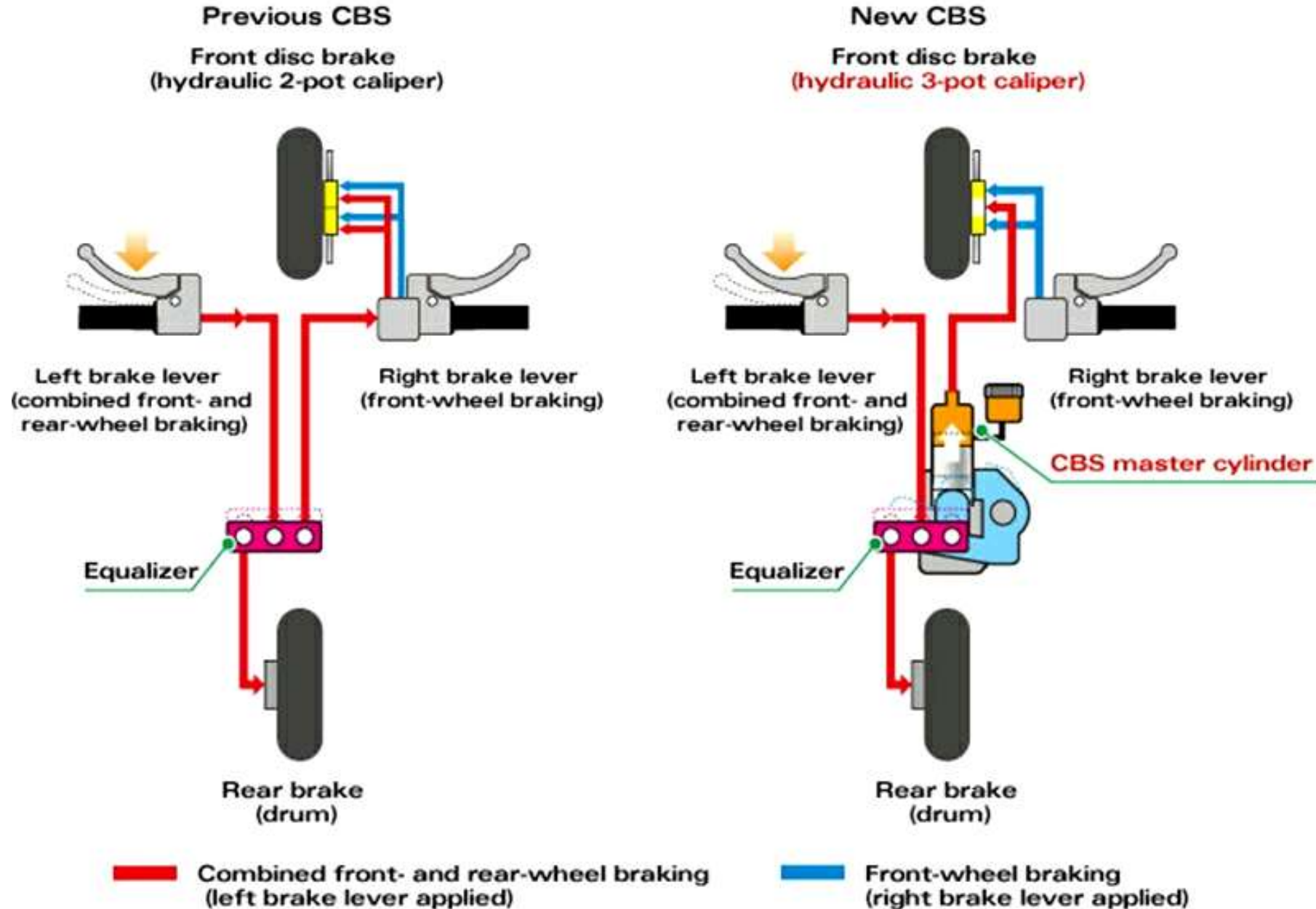




■ **New Combi Brake system**

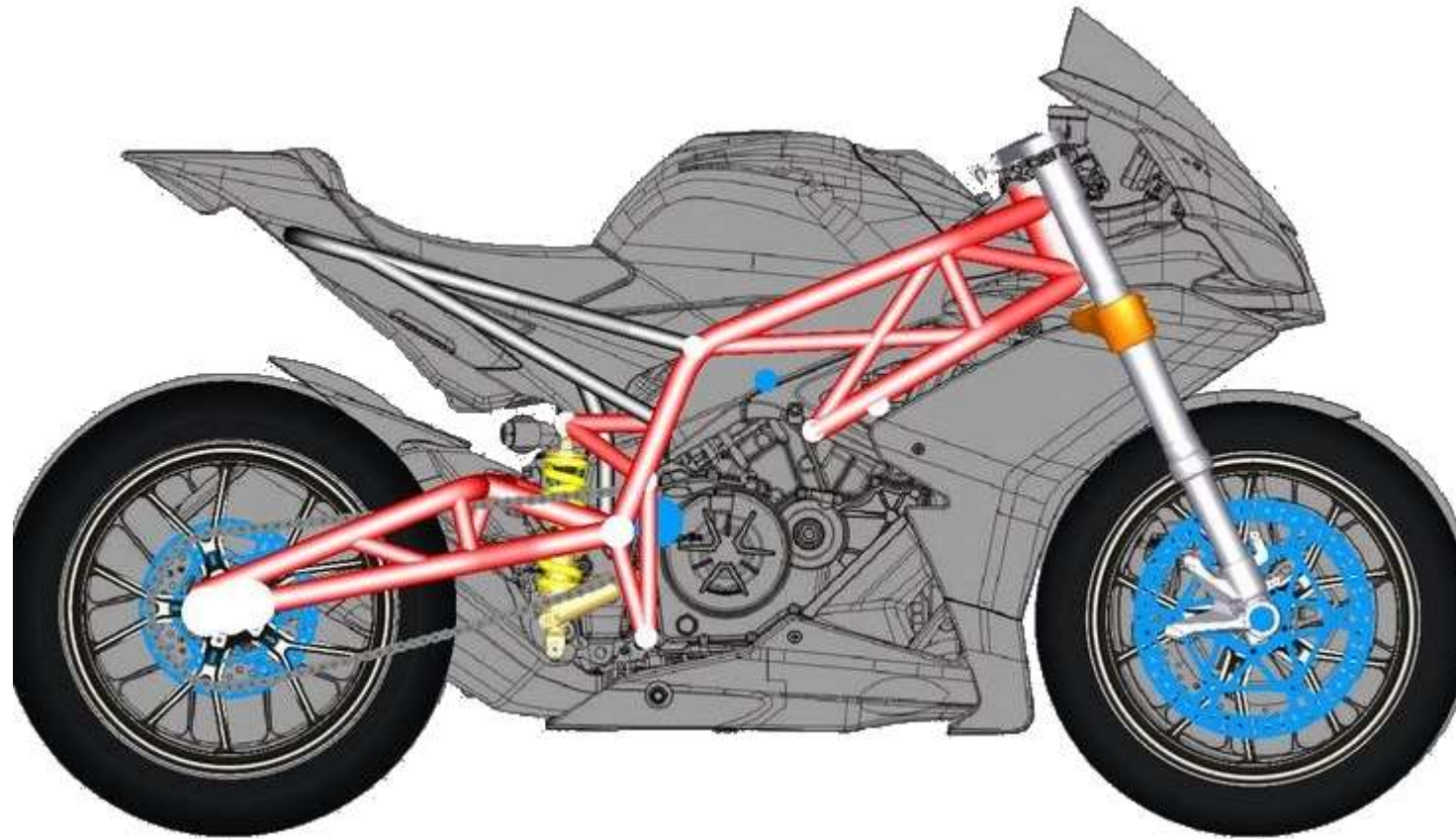


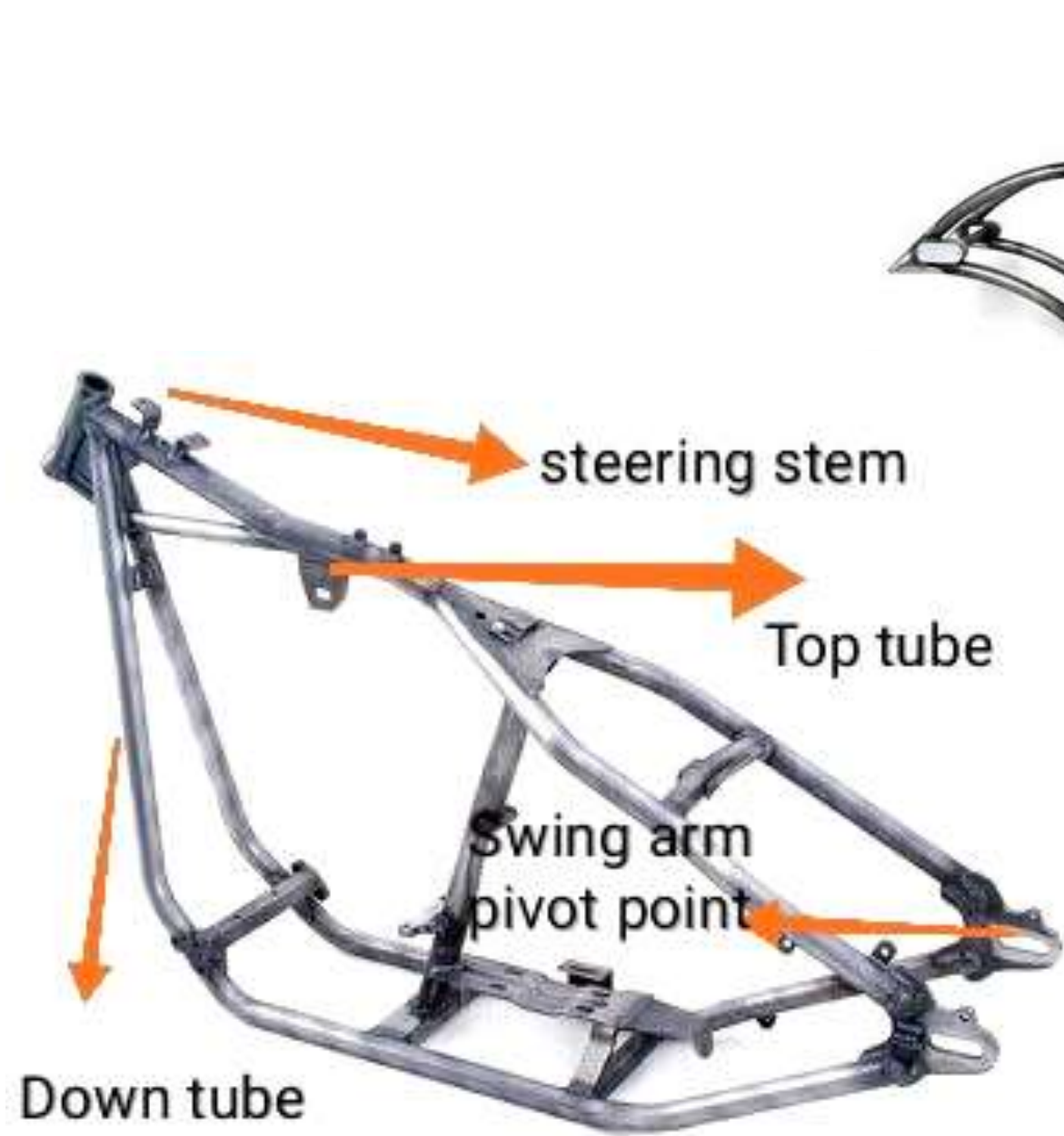
CBS (combined brake system)



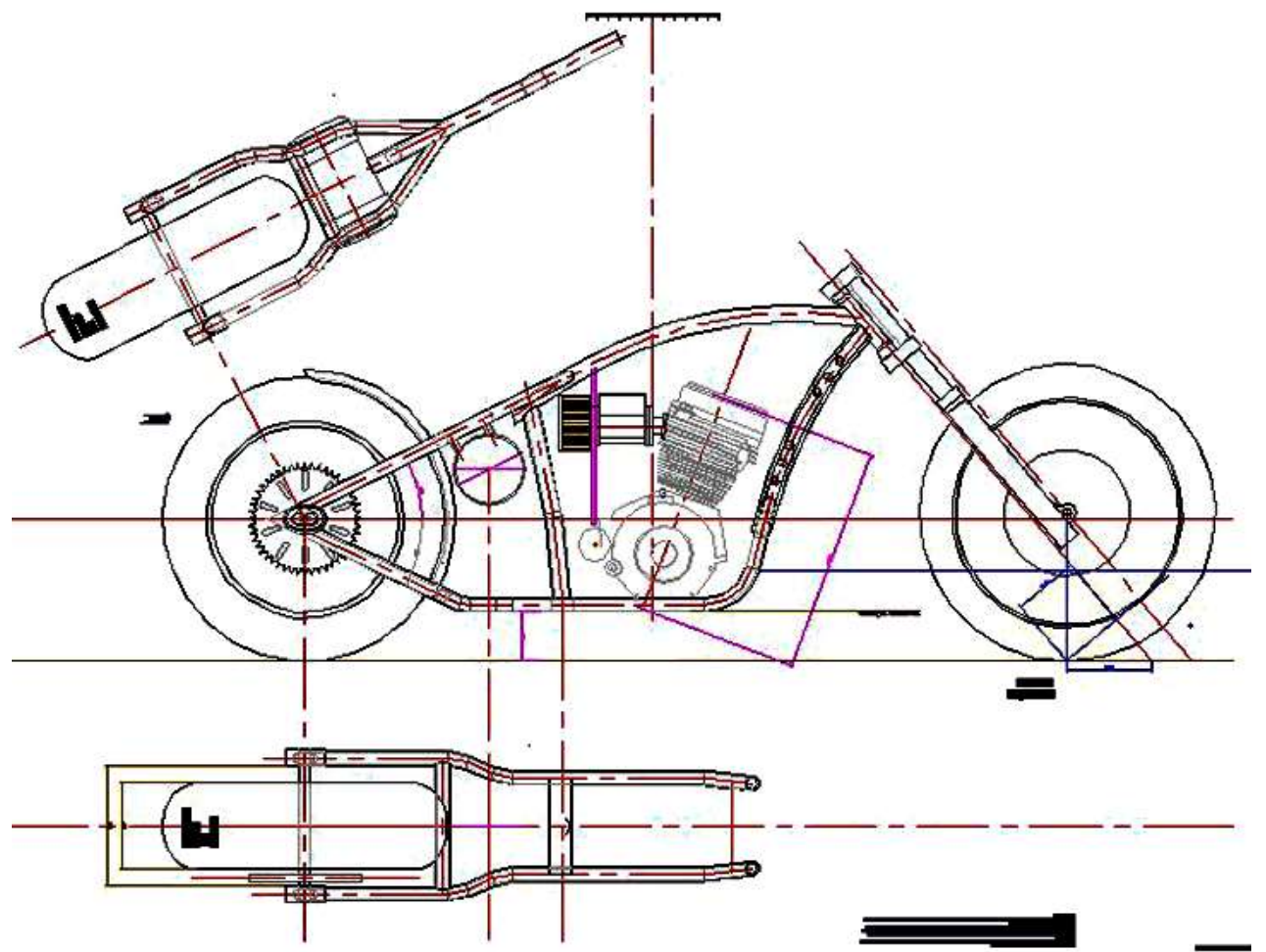
Motorcycle Frame

- The primary function of the motorcycle frame (also known as Motorcycle Chassis) is to hold the different parts together in one rigid structure and prevent it from falling apart. In other words, a motorcycle frame is its core structure or skeleton made to support the suspension, seats, handlebars, fuel tank, and engine. It also houses the steering equipment in the front with the help of a steering head tube.





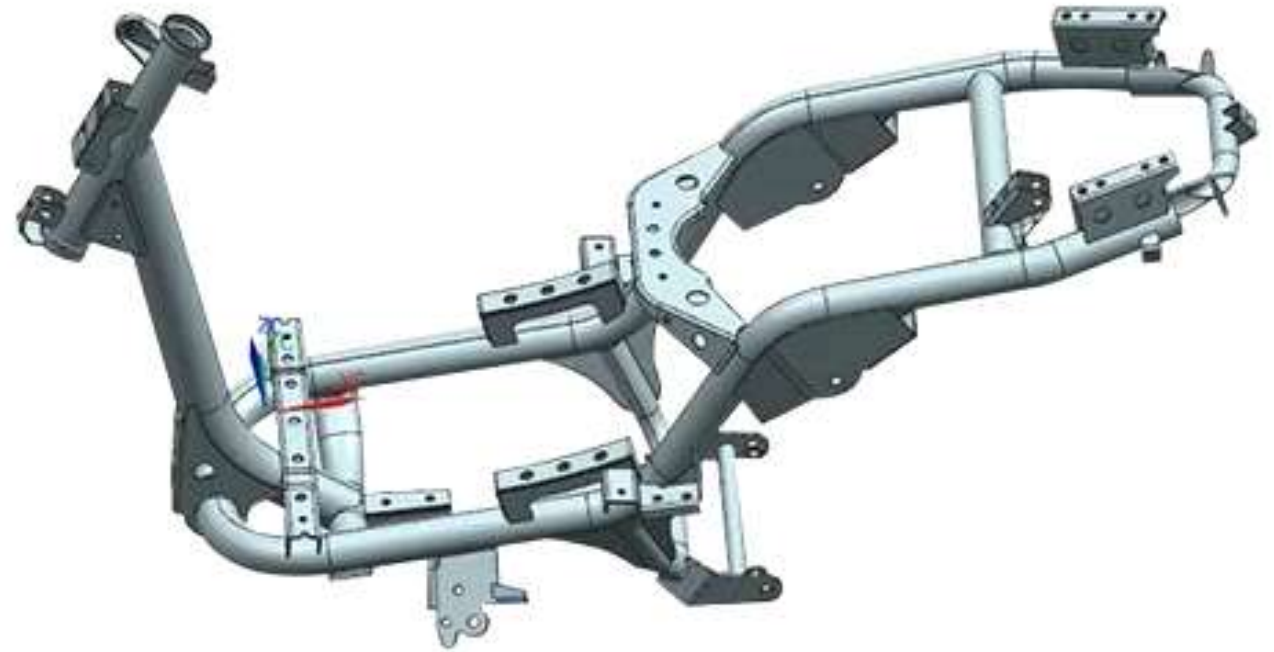
- Carbon fiber, titanium, steel and aluminum are by far the most common material used for bike frames



Scooter Frame

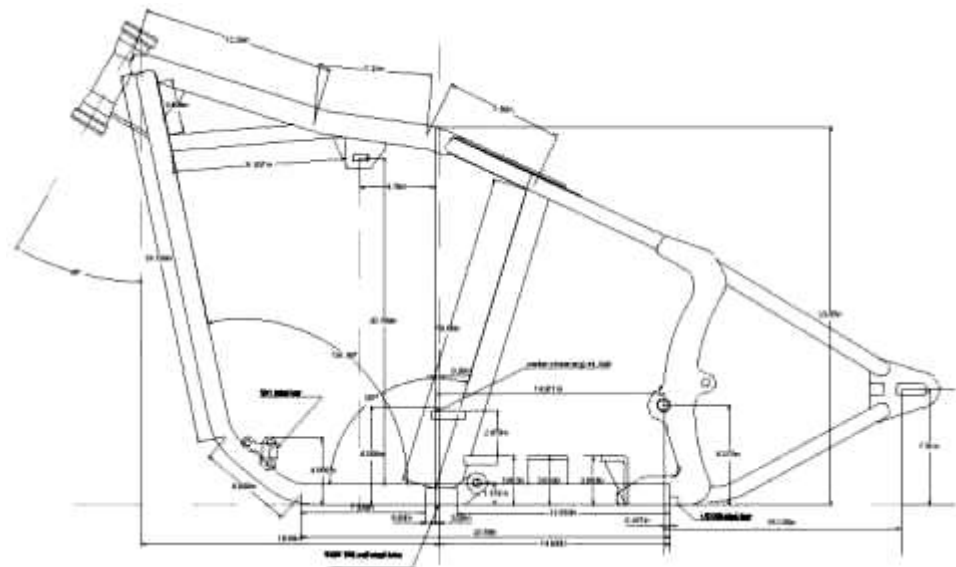
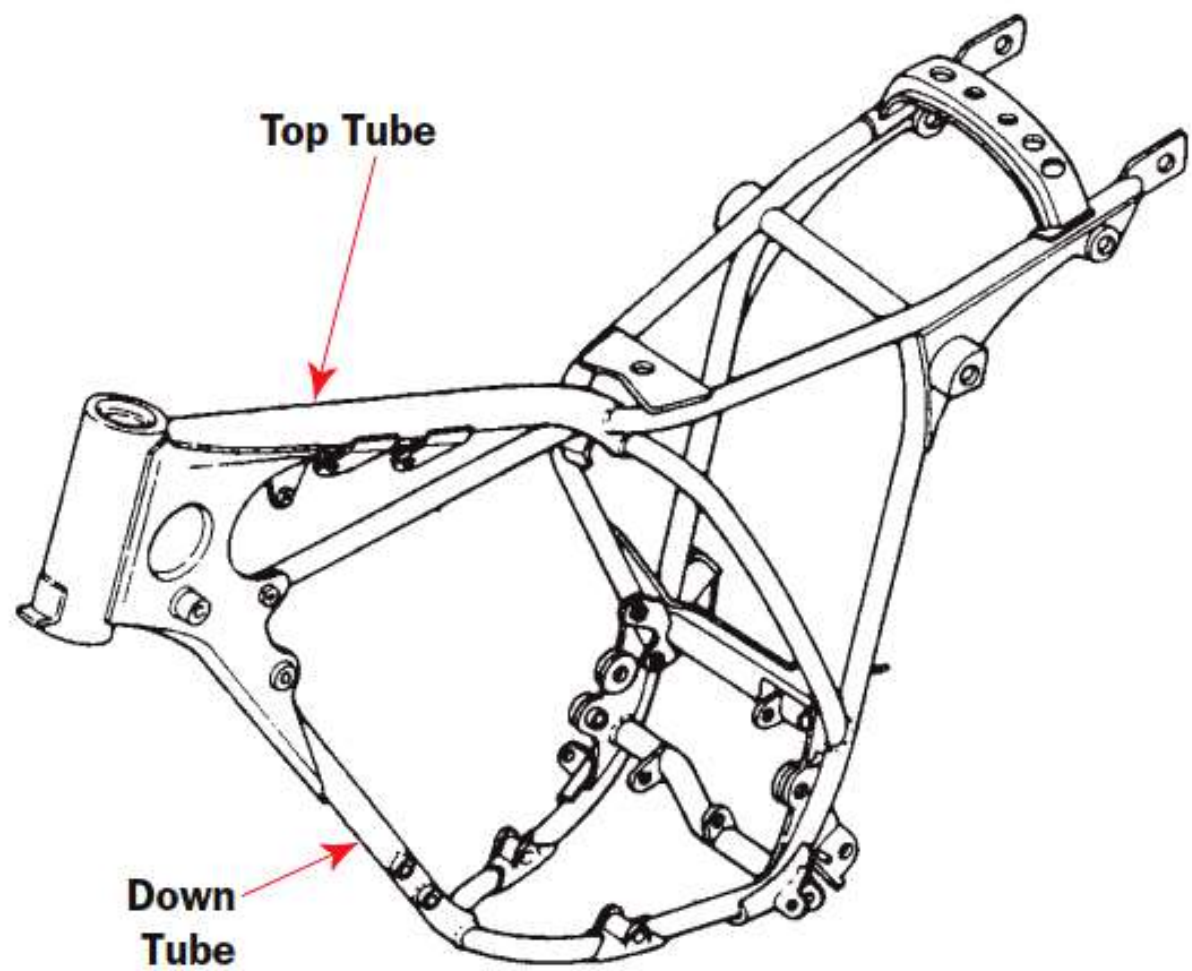


SCOOTER Frames



- **Single Cradle (Single Downtube)** A single cradle frame, also known as single downtube, is most commonly used on budget-friendly motorcycles. It mimics the look of a bicycle chassis. Here, the frame acts as a bed for the engine with two tubes connecting the steering head or yoke



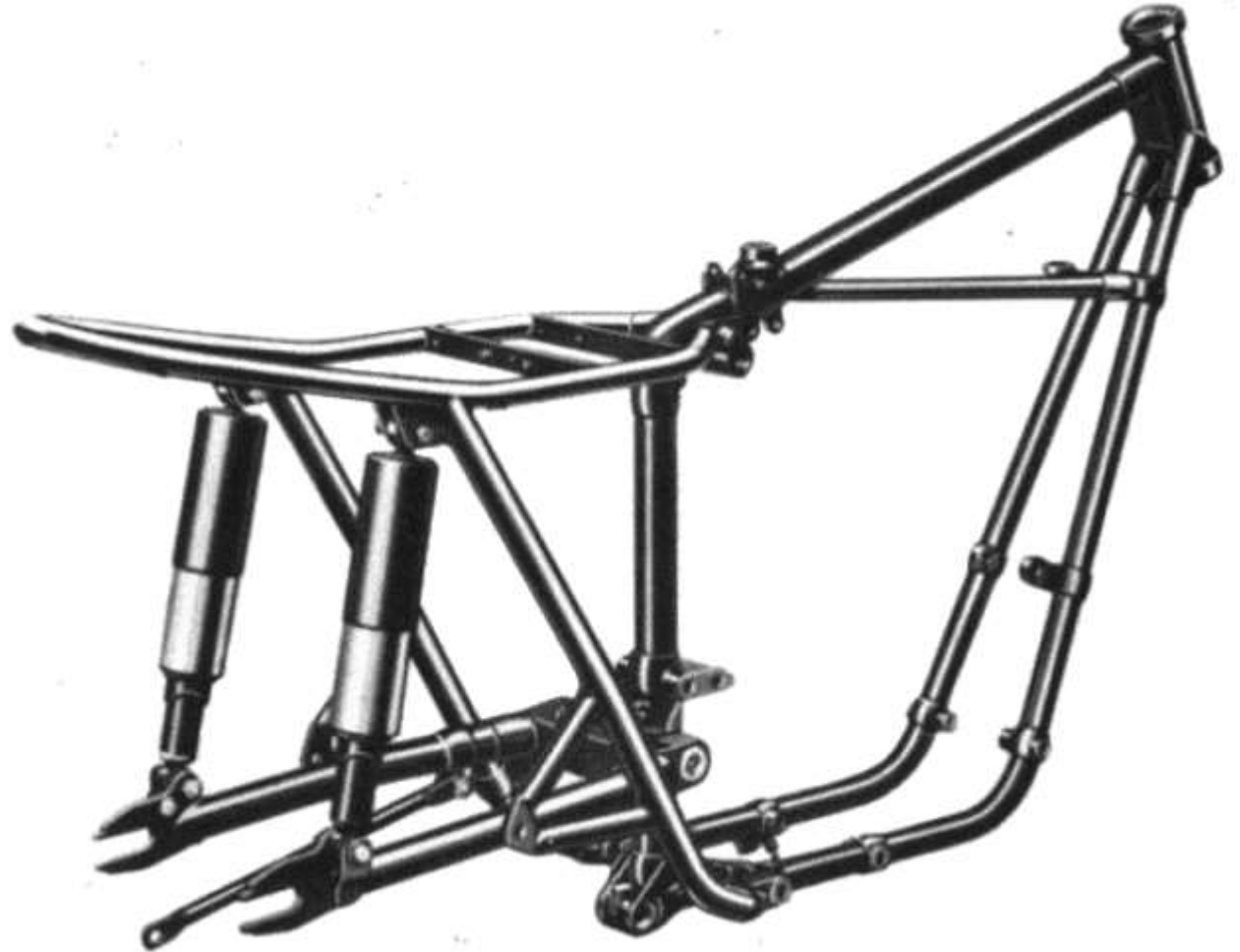


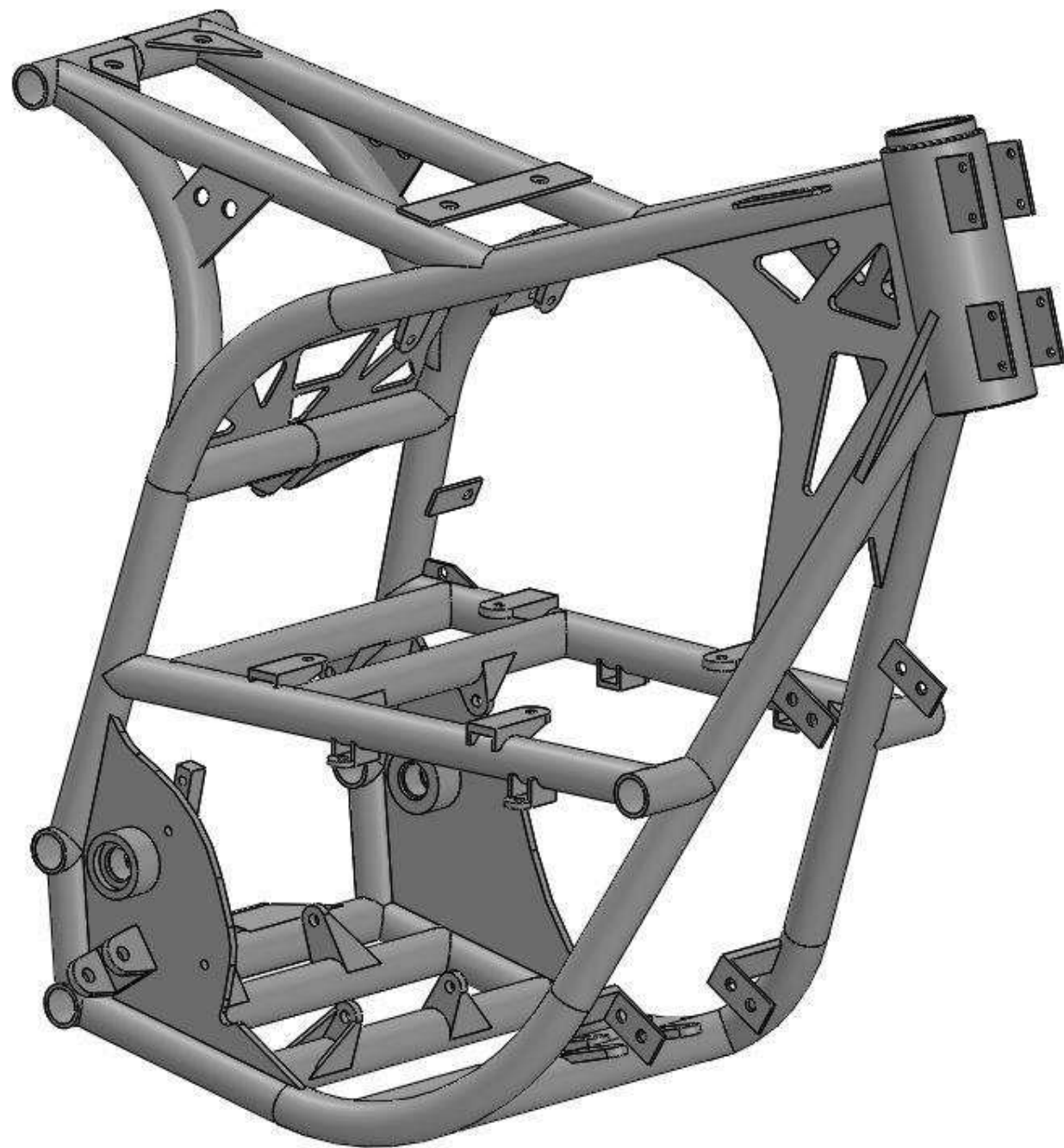
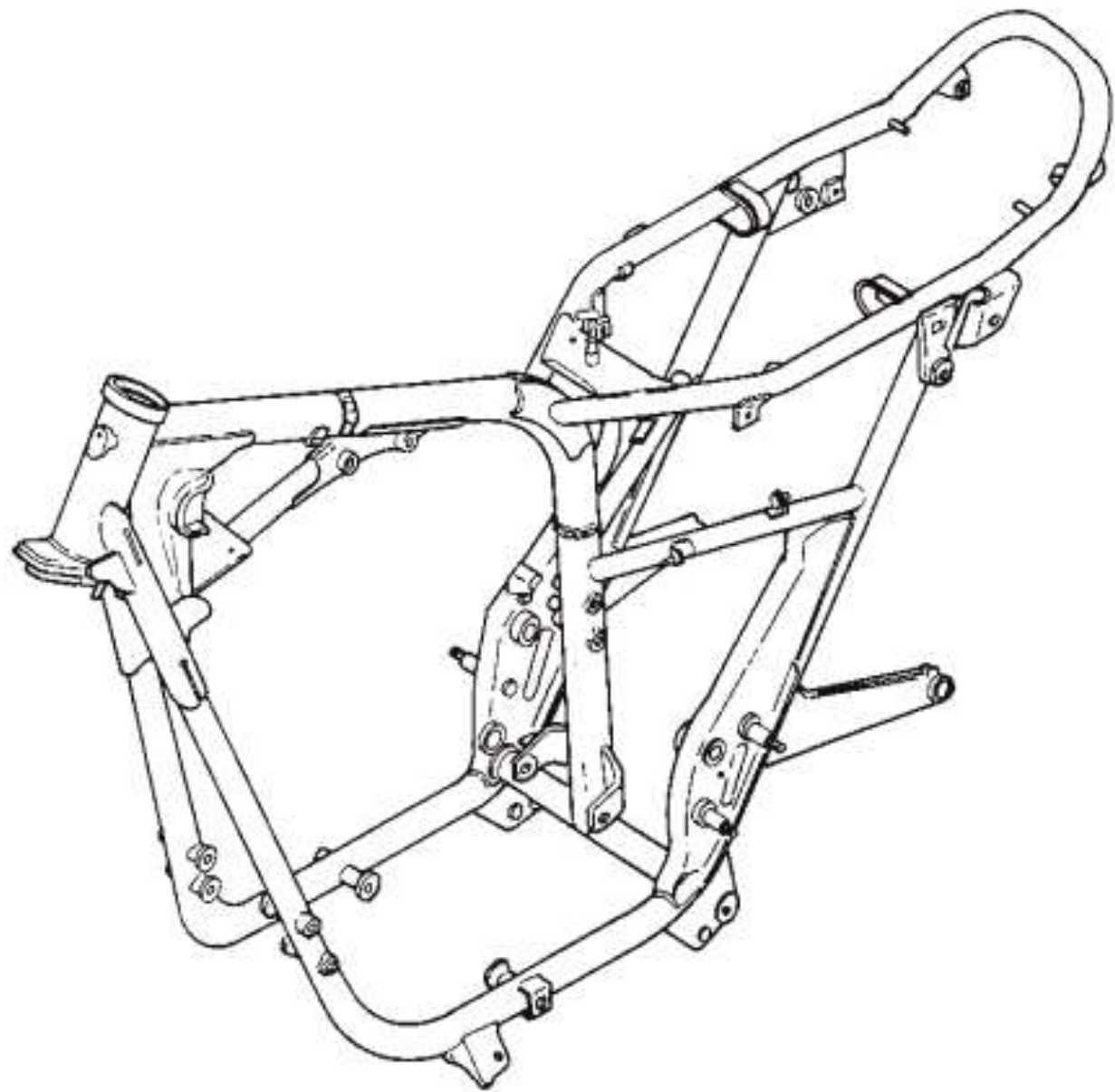


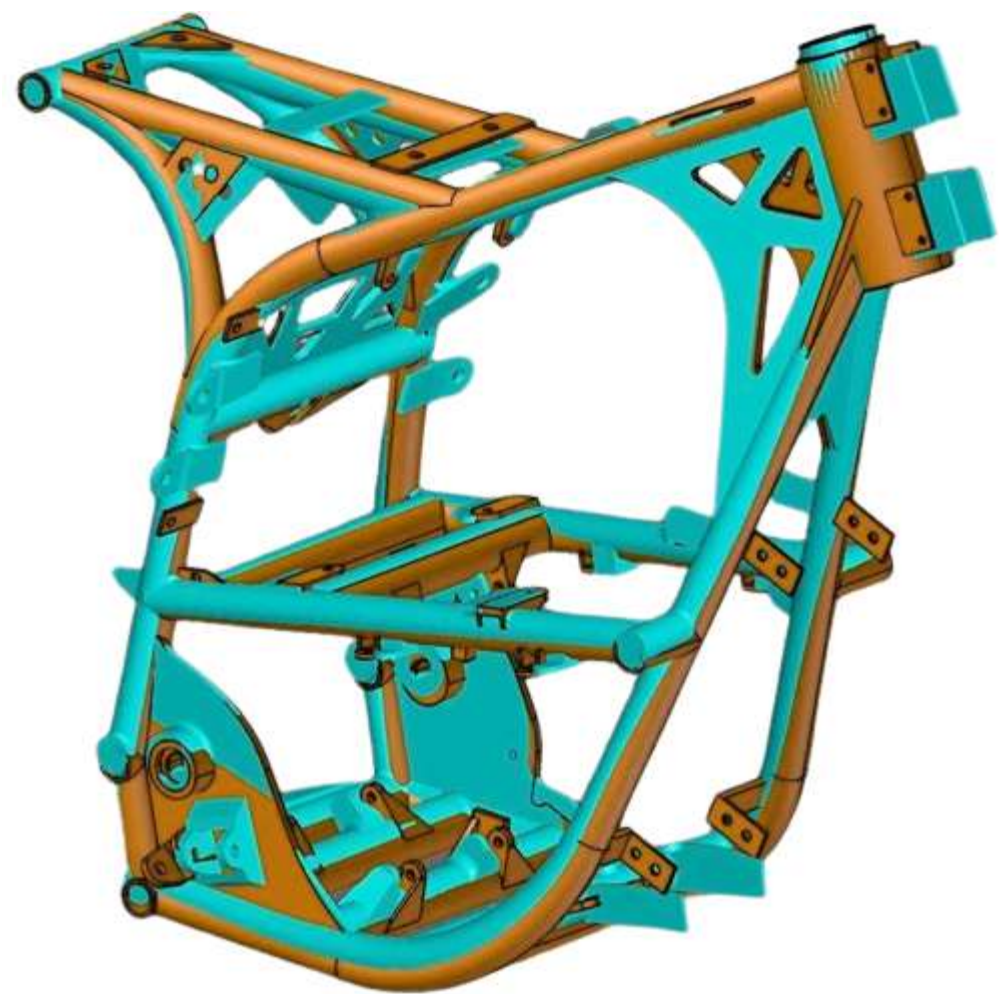
HONDA CG125



- **Double Cradle (Double Downtube)** A double-cradle frame uses two tubes running beneath the engine in order to support it instead of one steel tube on a single cradle frame. While the frame is cost-effective, it provides a significant advantage over a downtube chassis in terms of strength and rigidity.







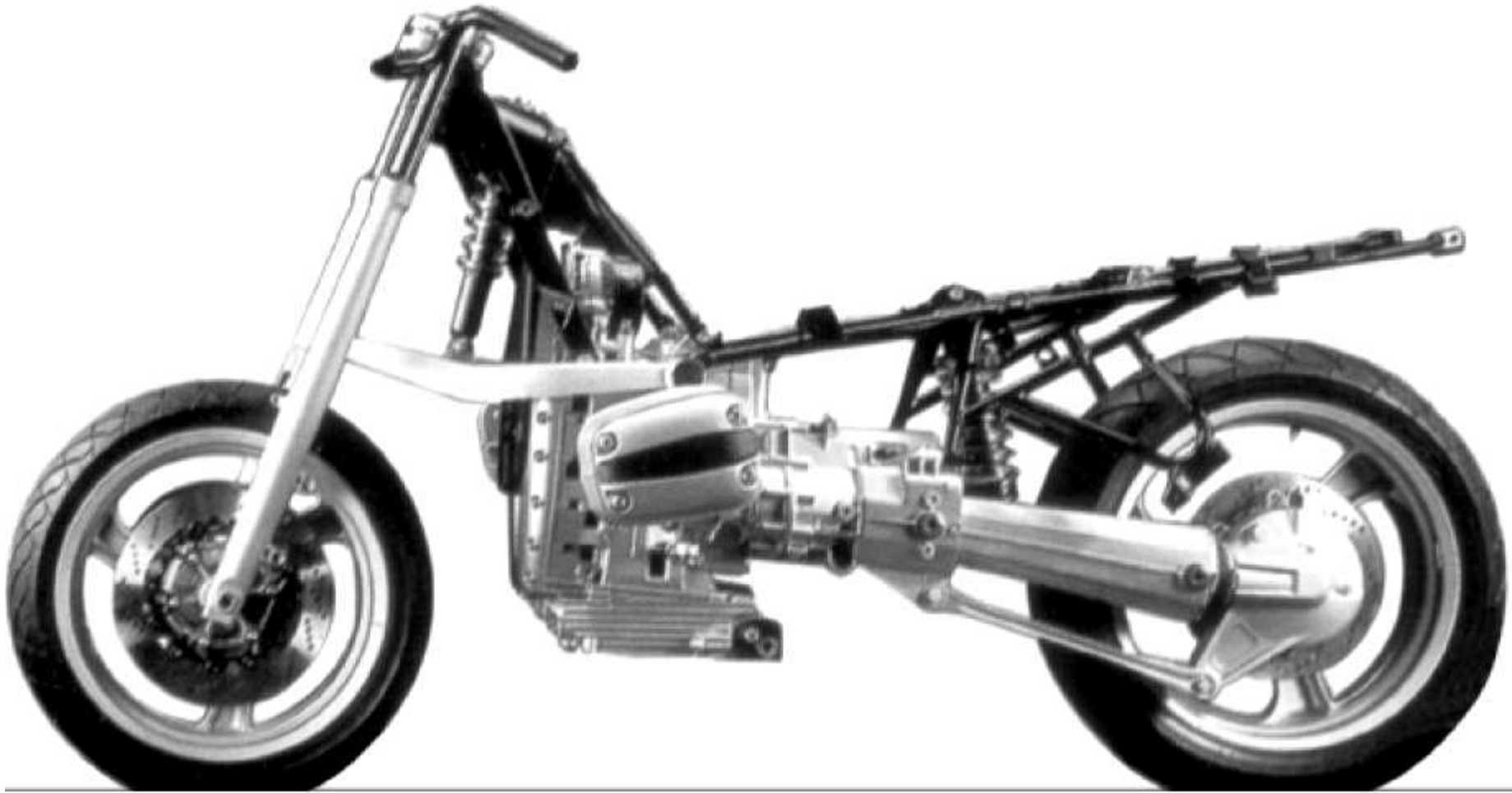


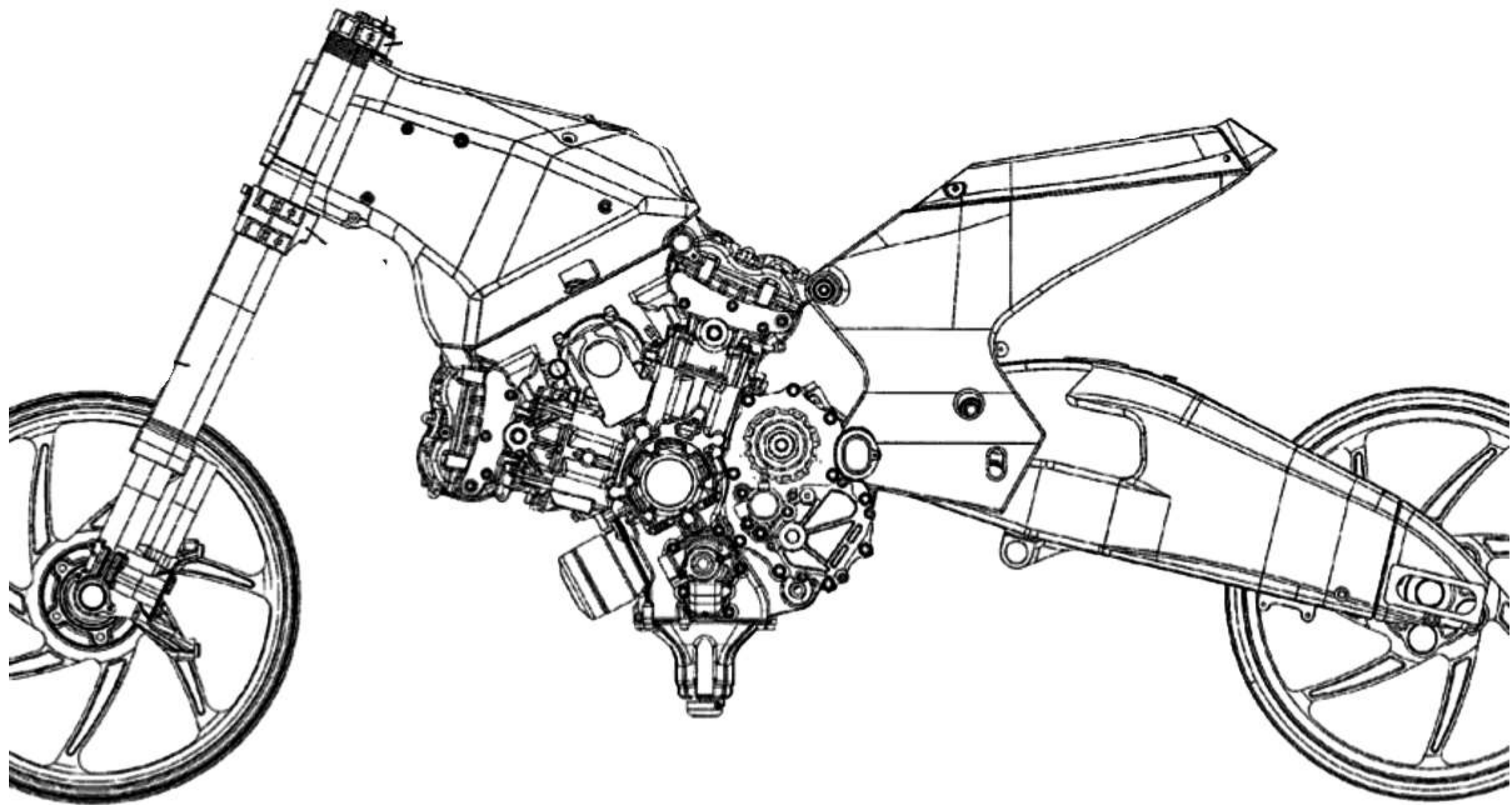
Suzuki TS50X

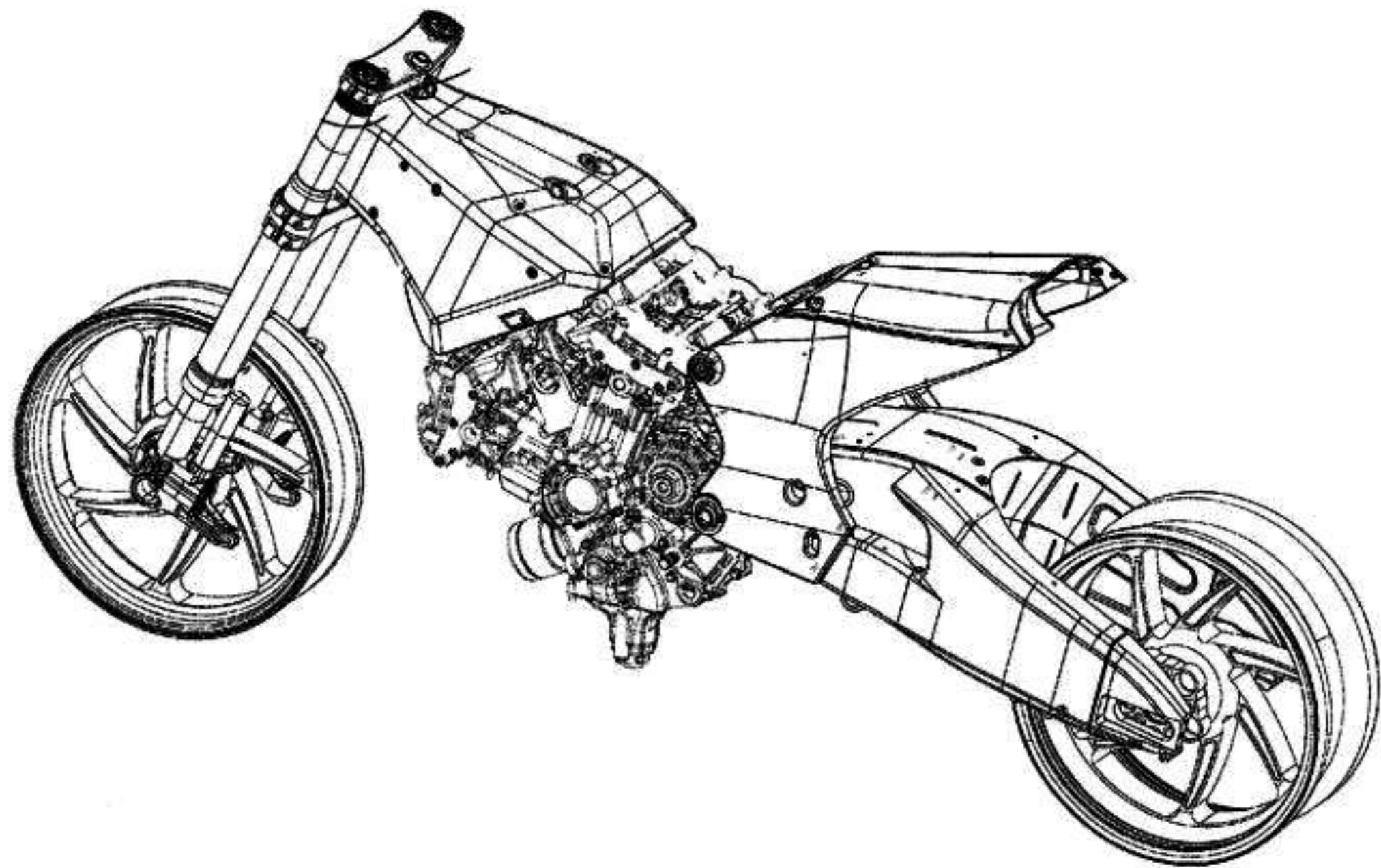


Manx Norton 1962

- **Stressed Engine** In a stressed member the engine itself forms an integral part of a frame. Here it looks like a jaw holding an object or otherwise the engine is a structural part and load bearing component suspended with the help of bolts. The engine never rests inside the frame





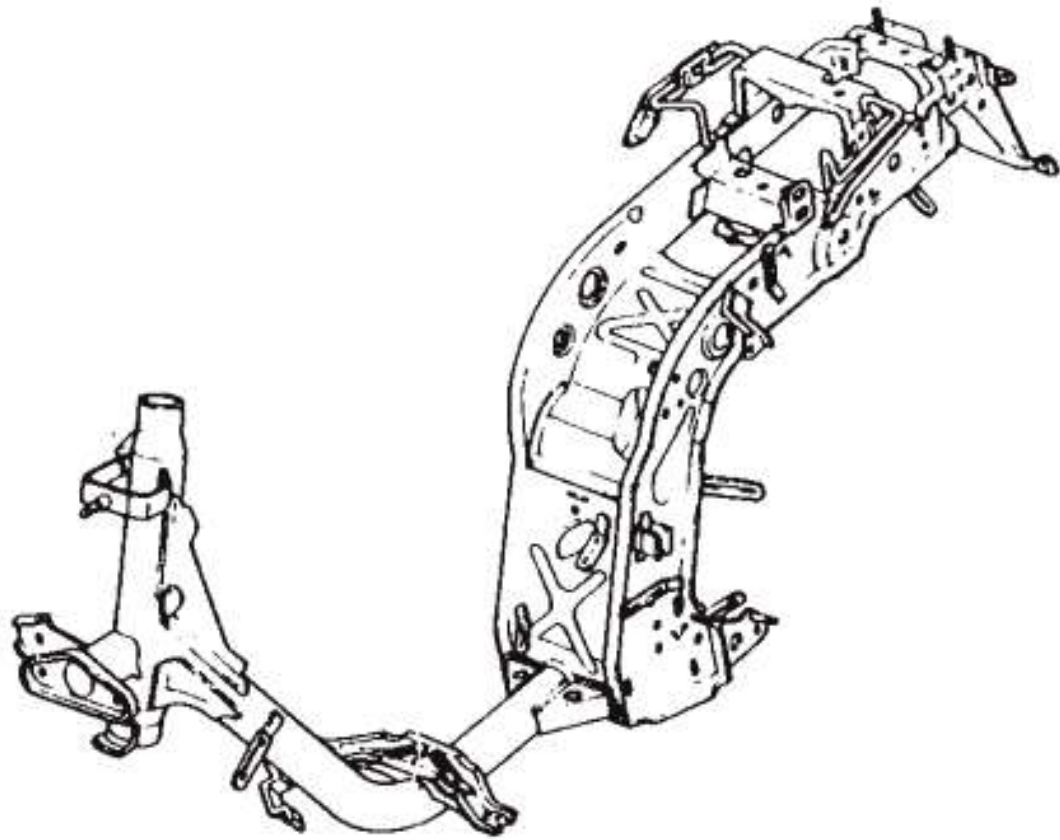


- Using the engine as a stressed member helps with reducing the weight of the vehicle (Motorcycle) and with centralizing its mass. However, there is a possibility of reduced engine life if the engine mounting is in any way improper, Also stressed engine frame could be noisy or uncomfortable because of the vibrations and maintenance could be tricky.



- **Spine or Beam Frames (Backbone)** The backbone frame is shaped like a spine and holds important bike parts in place, and the engine is attached to the frame. The amount of product used to make this is lesser than other frame types, making it very cost-effective.



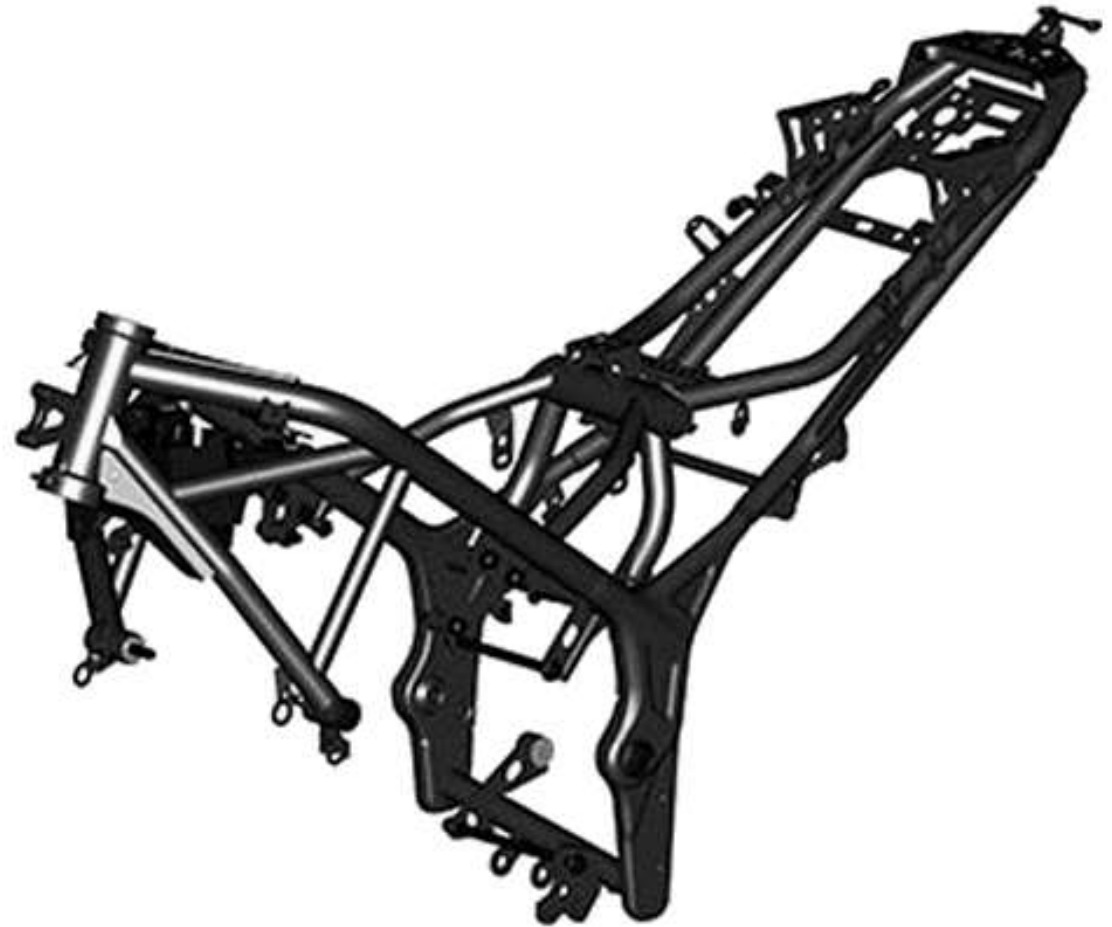




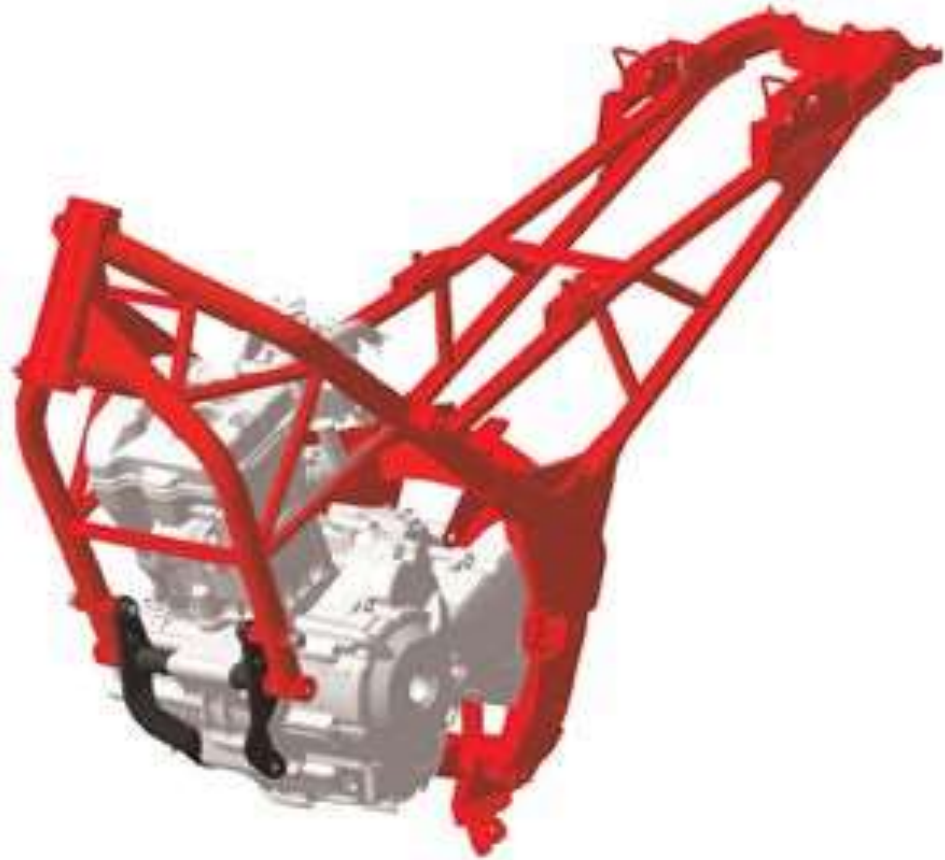
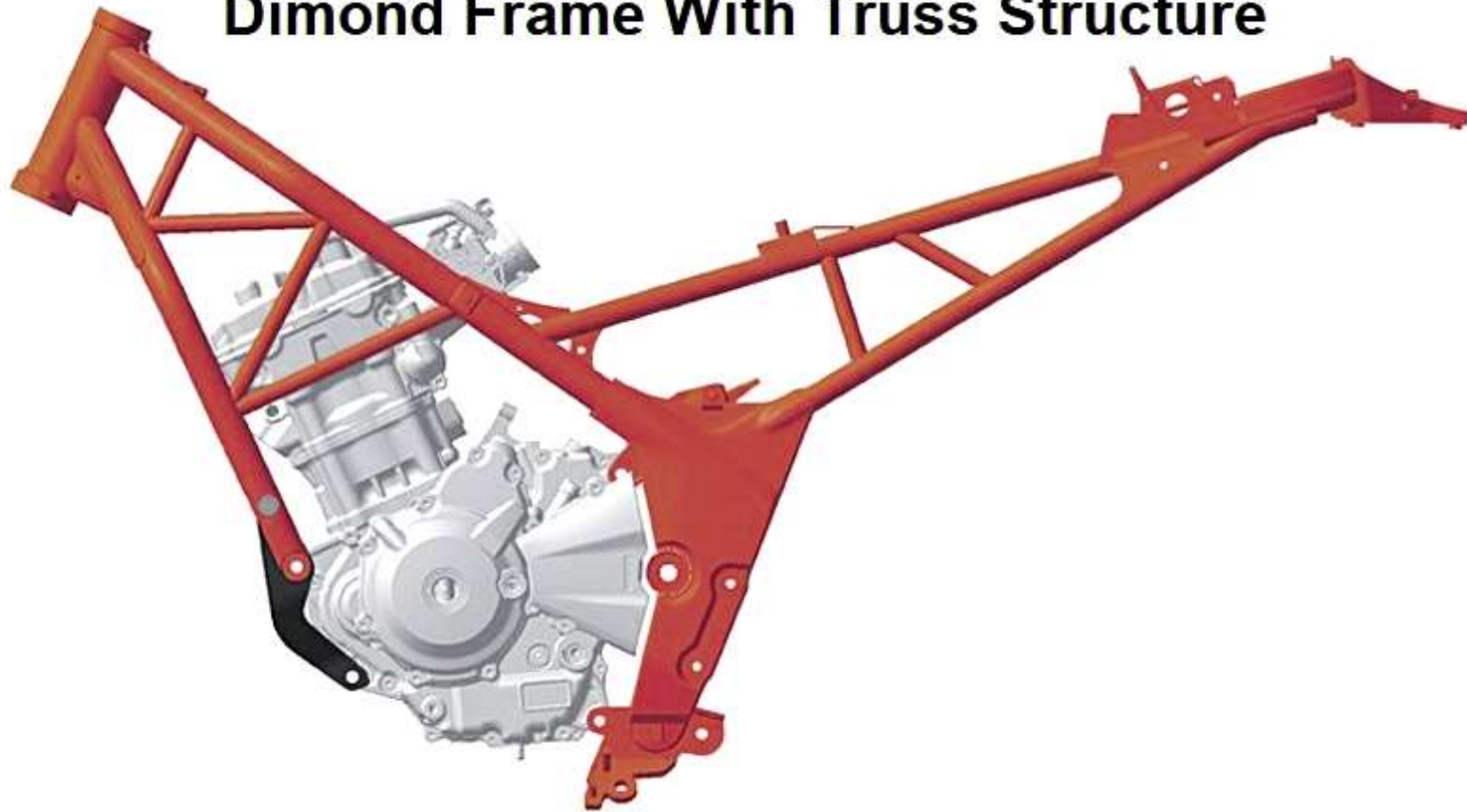
Honda CB92



- **Diamond Frames:** Diamond frame is circular in shape so that the name Diamond is more consistent with it and is used with minor modifications for use in motorcycles. In the diamond frame, the steering head is attached to the chassis via a single beam. This frame may look less powerful but this frame is actually much stronger. Here the pipe descending from the steering head actually provides very good support to hold the engine. The diamond frame is light in weight making it easy to use on any bike

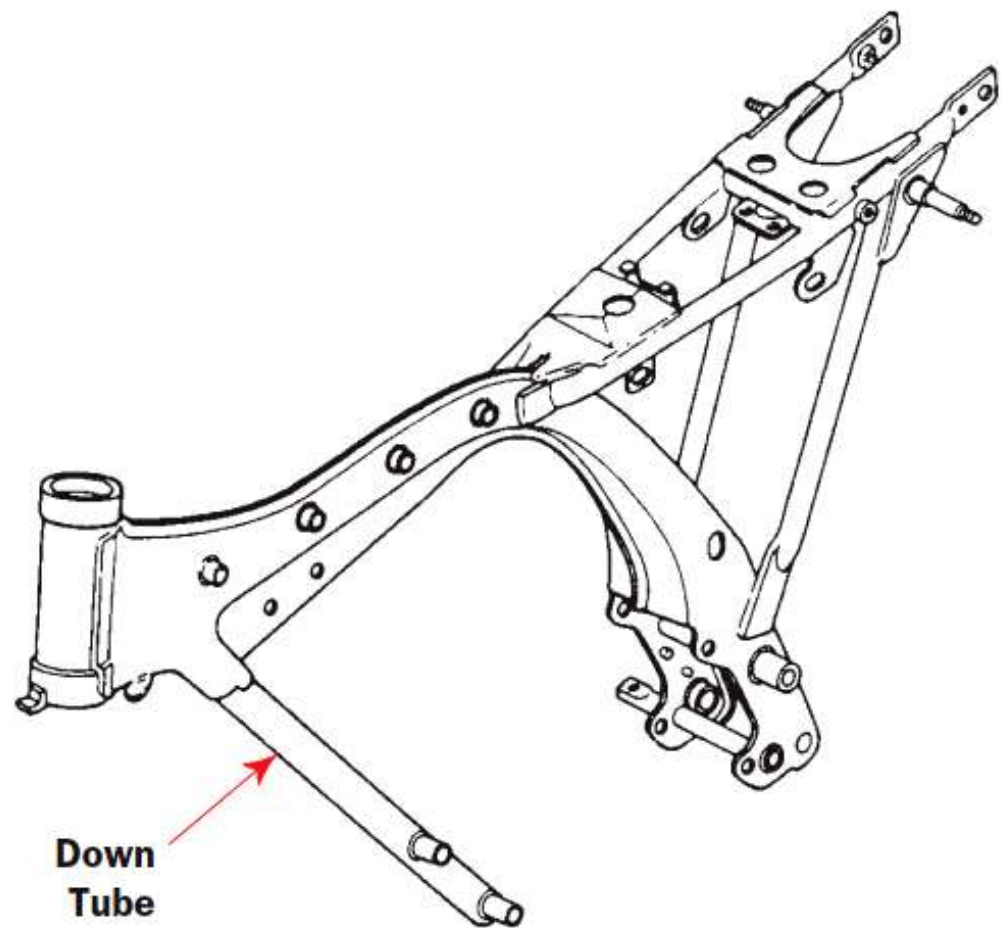


Dimond Frame With Truss Structure



YAMAHA FZS-FI

Diamond Frame

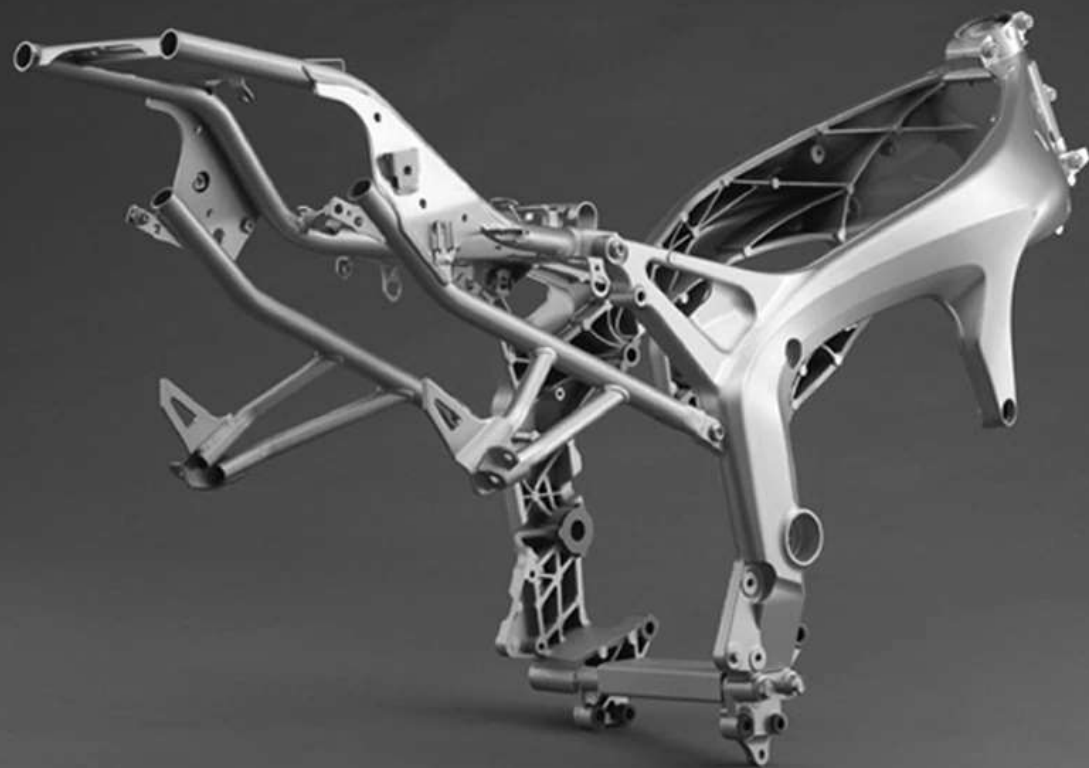


- **Twin-Spar Aluminum Frames (Twin-Spar Beam)**

The two beams or the twin spars after which the frame is named surround the engine as they reach out for the swing-arm pivot. While earlier twin-spar frames were made of steel, almost all modern twin spar frames are made of lightweight aluminum.



R1 YAMAHA



YAMAHA FZR600



HONDA CBR1000RR



· CBR 1000 RR-R SP 2020

· 35mm

· Canon EOS M2

· 1/4000 1/400 1/2.8

- **Trellis:** A frame connects the steering head to the swingarm pivot as directly as possible using metal tube arranged in triangulated reinforcement. Using lattice girder principles, a trellis frame is typically constructed of round or oval section metal tubular segments that are welded or brazed together



Ducati S4 Fogarty



Trellis Frame System



- **Monocoque:**

A monocoque frame comprises a structure where loads are supported through its external skin. On motorcycles they are used almost exclusively on racing motorcycles.



Johan Player Norton



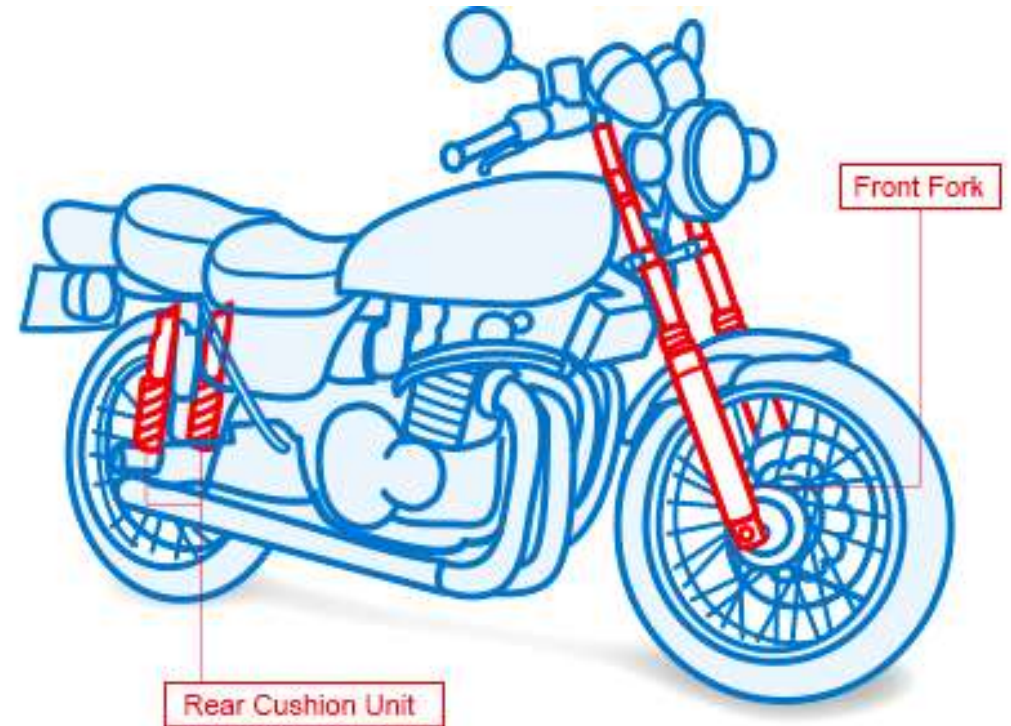
DNA's honeycomb monocoque BMW



Motorcycle Suspension System



- A **motorcycle's suspension** serves a dual purpose: contributing to the vehicle's handling and braking, and providing safety and comfort by keeping the vehicle's passengers comfortably isolated from road noise, bumps and vibrations.

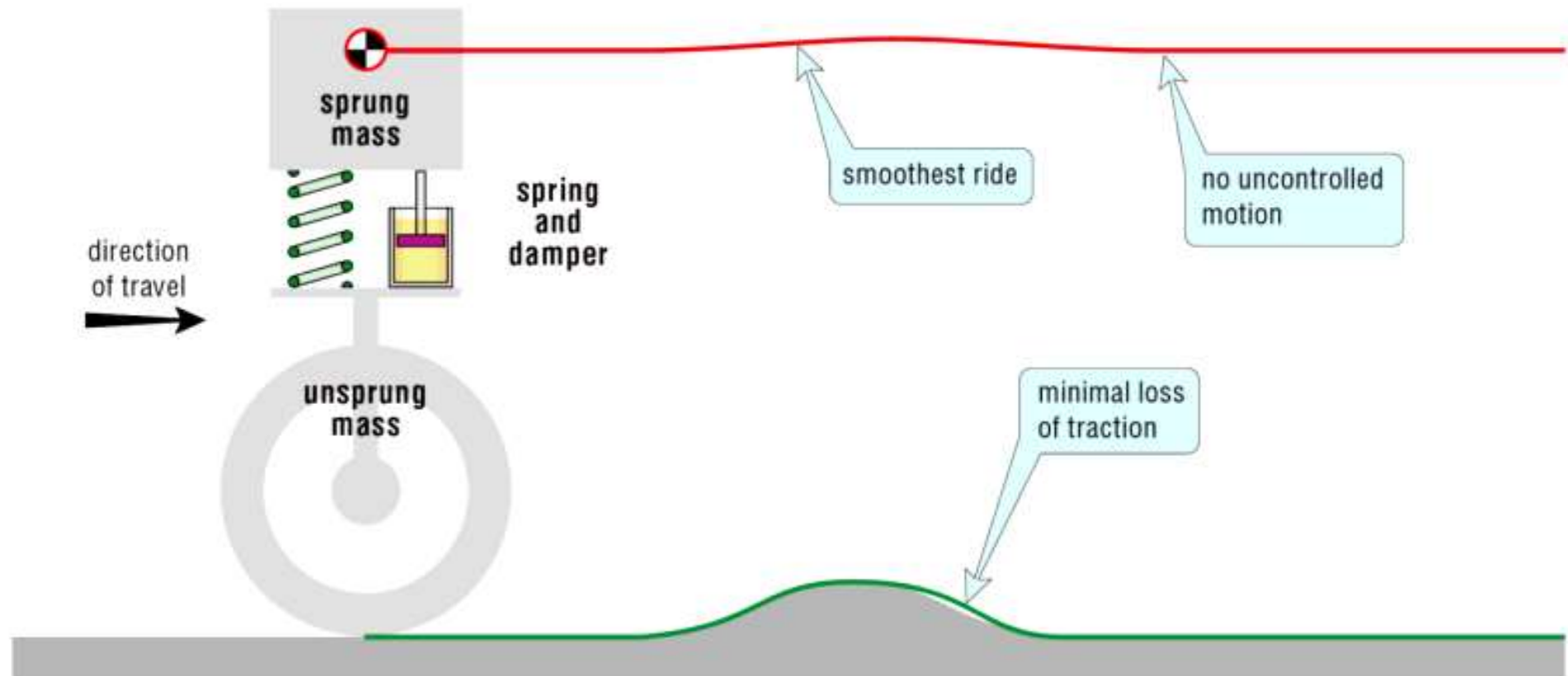


- The **suspension** is the system that's responsible for maintaining the tires' contact with the road, minimizing the impact of dips and bumps on the surface. Motorcycles are designed with a front and rear suspension.



There are four main parameters that affect suspension performance:

1. Springing.
2. Damping.
3. Sprung and unsprung masses (The unsprung weight is the wheel, tire, brake discs, calipers, axle, and lower fork sliders. The sprung weight is everything supported by the springs—engine, chassis, fuel, and rider)
4. Tyre characteristics



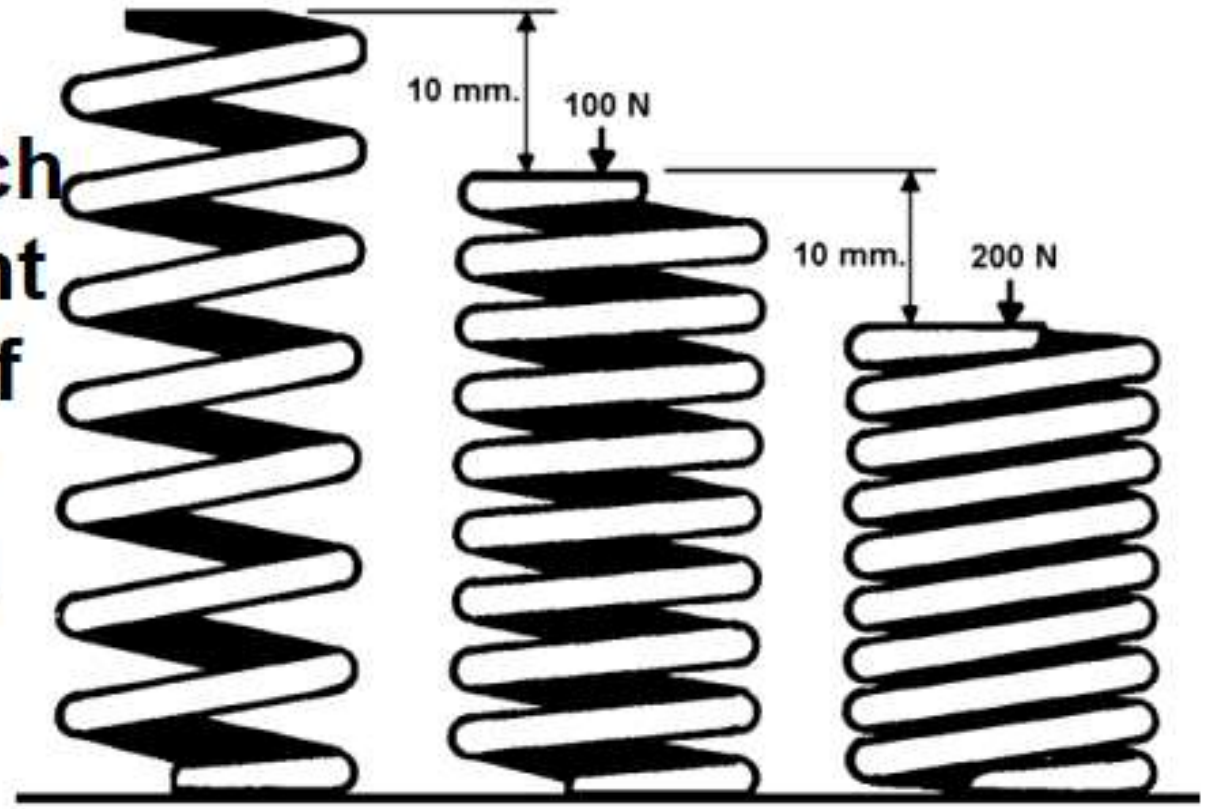
- A **spring** is an essential part of the motorcycle. It has to keep the motorcycle, with rider, passenger, luggage in the correct riding position and keep the wheels in contact with the road, while shifting up, while braking, while cornering, on the straight, in short, in every circumstance.

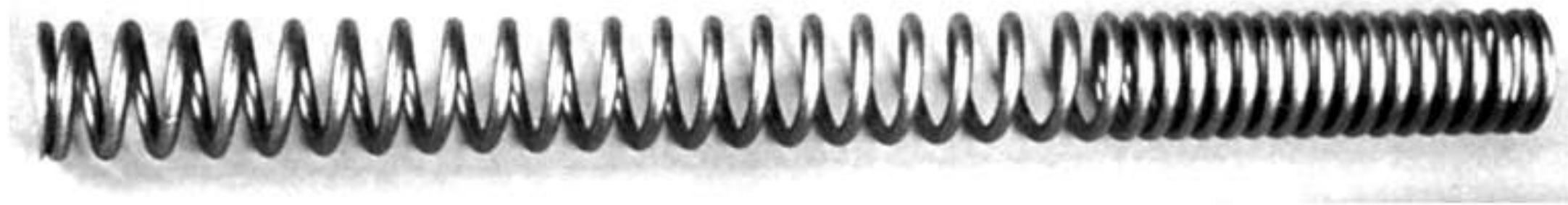


- **Coil Springs**
are designed support the vehicle's (Motorcycle) weight. They compress and absorb road impacts, allowing the frame and body of the vehicle to experience minimal disturbances when riding over bumps such as railroad tracks or dips such as potholes.



The spring shown has a constant rate of 10 N/mm.. Each additional 10 mm. of movement requires an additional 100 N of axial load. This doesn't apply when the spring becomes coil bound, then it effectively becomes solid

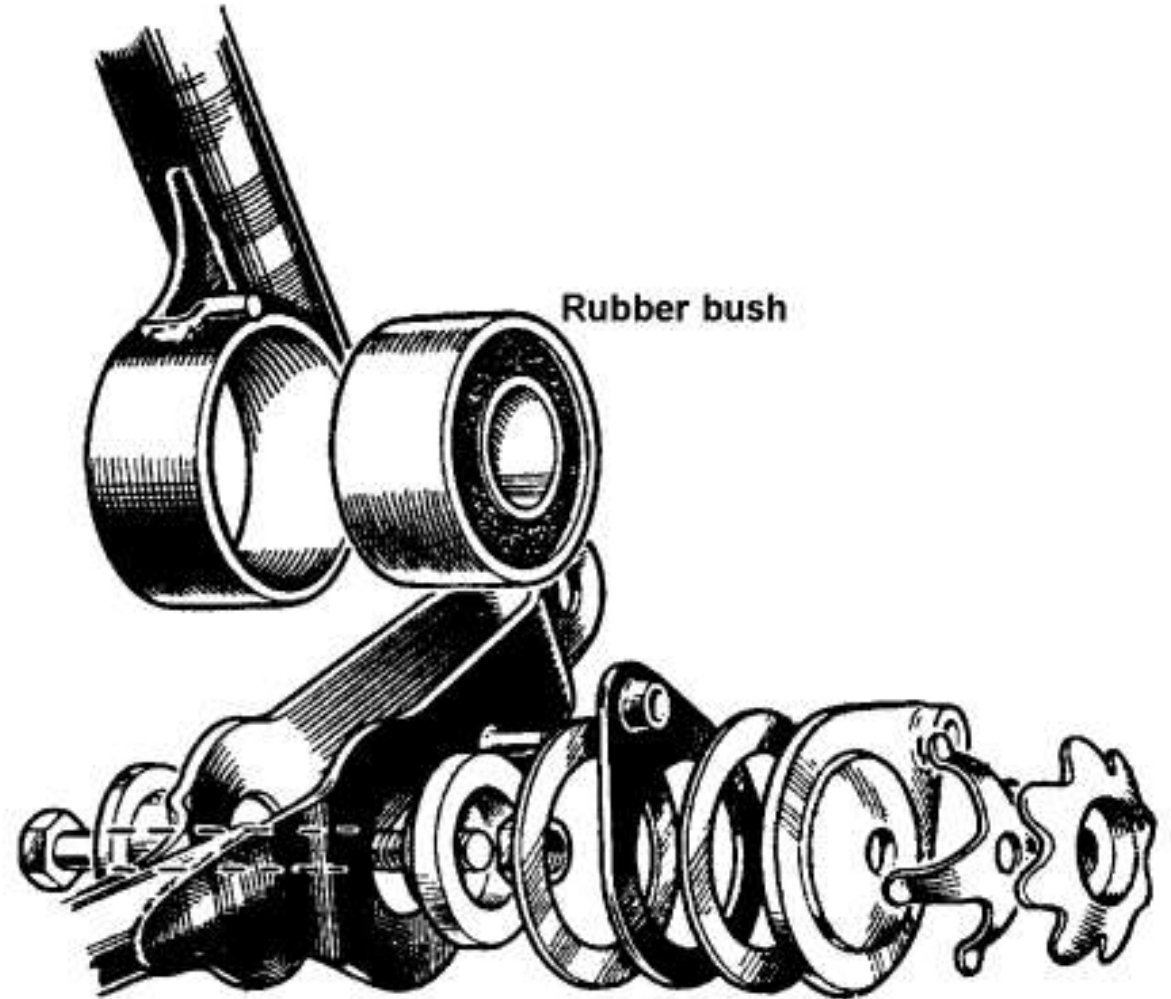




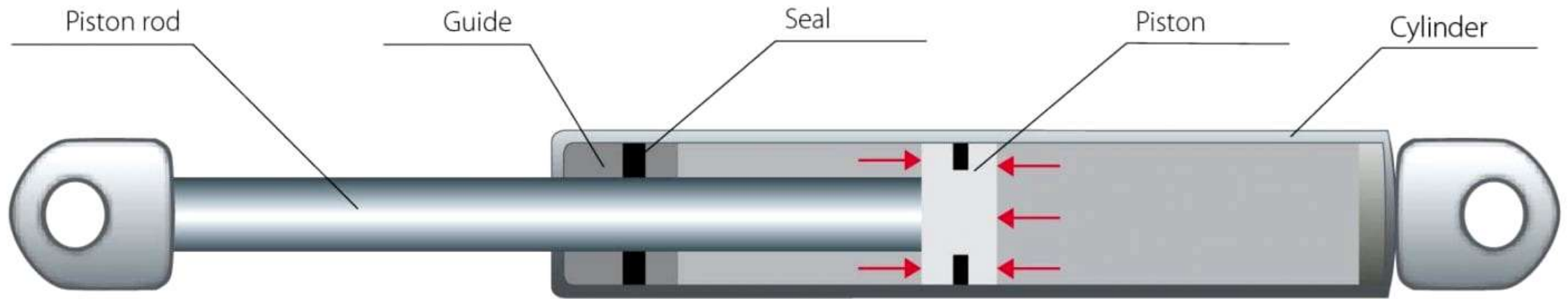
Typical dual rate front fork spring. There are two distinct pitches, as load is applied the closer wound coils on the right will become coil bound and act as a solid spacer, hence leaving less coils to the left to deform under load. That is, as the load increases the spring rate also increases

- Rubber spring

Rubber springing.
Exploded view of early
Greeves front fork pivot
showing bonded
rubber bush. Although the
bush was loaded in torsion
the rubber itself was
stressed in shear

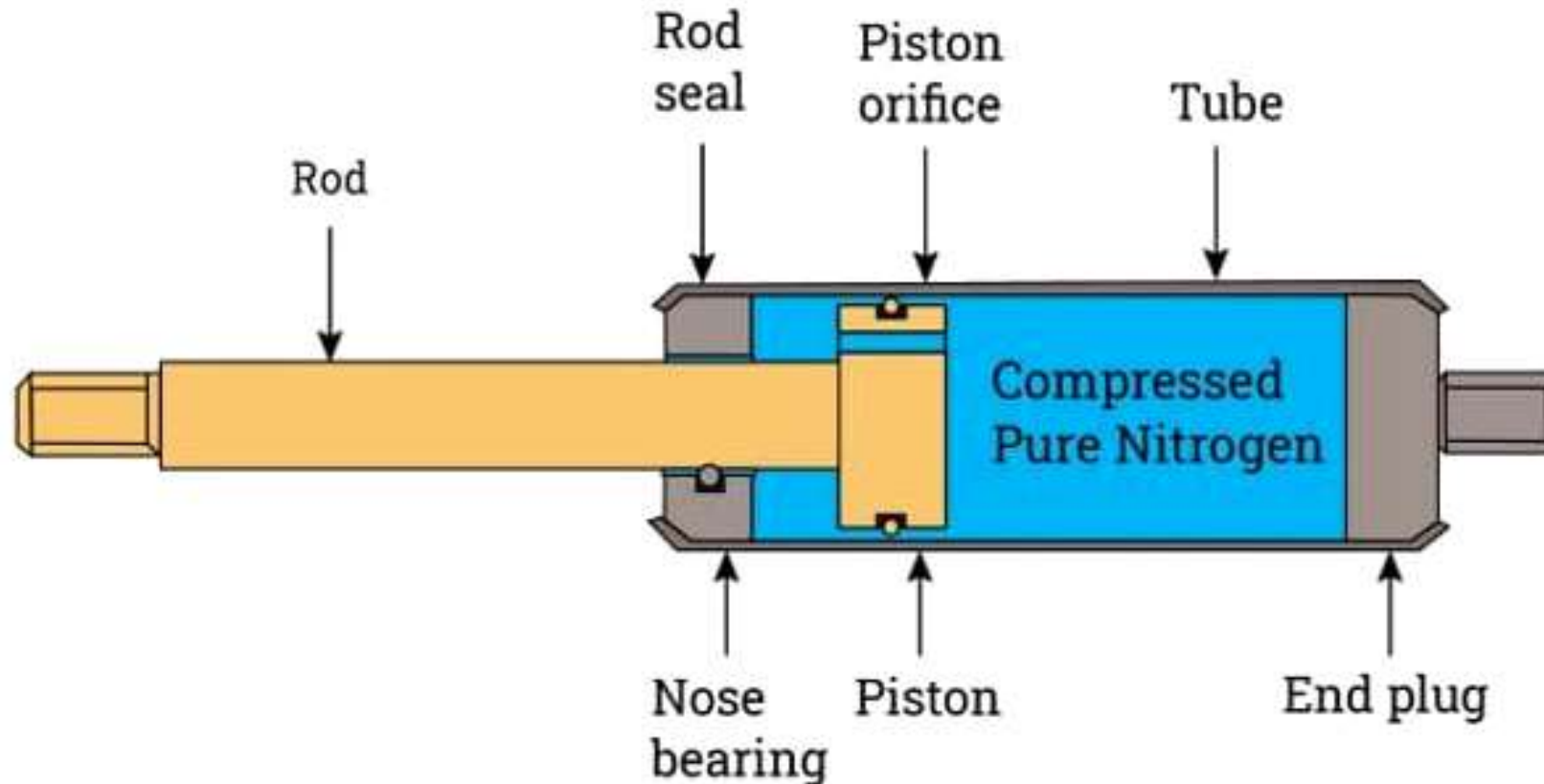


- **Gas spring:** Gas springs can be defined as hydro-pneumatic, energy storage elements. Nitrogen gas and oil are utilized for providing compressible and damping (motion control) mediums. Gas springs can be configured to meet a wide range of requirements.

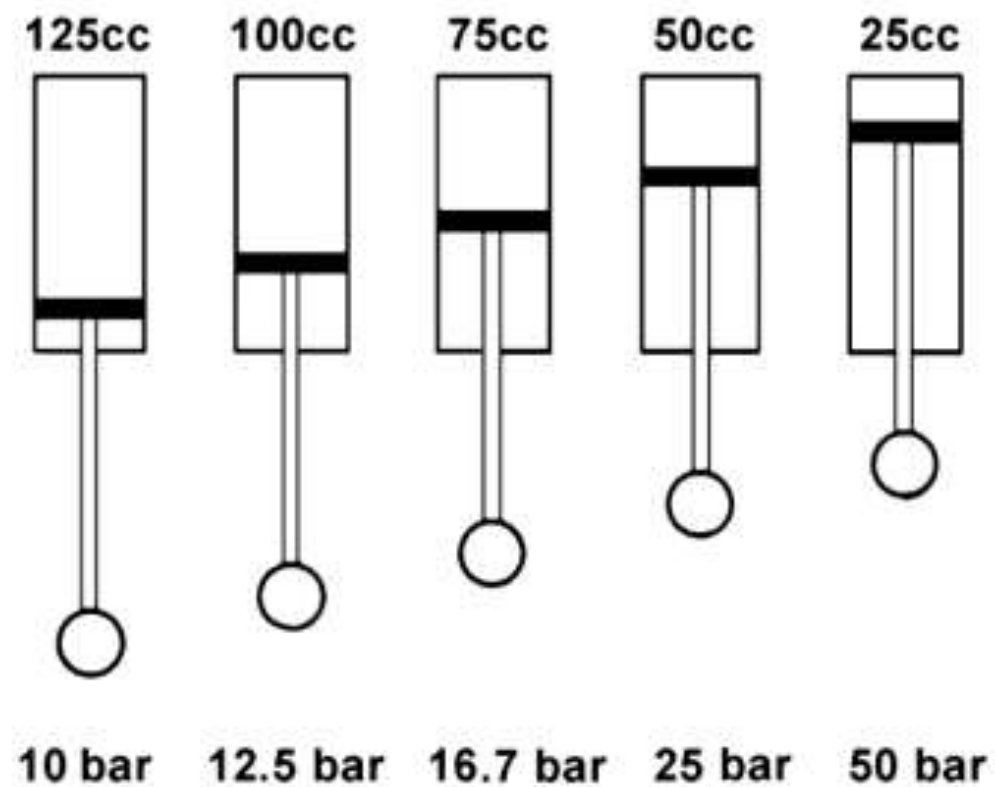


- Gas pressure internal to the strut provides a push or pull force depending on configuration, but also contains a damping circuit typically to control the speed of motion through one or both directions of travel

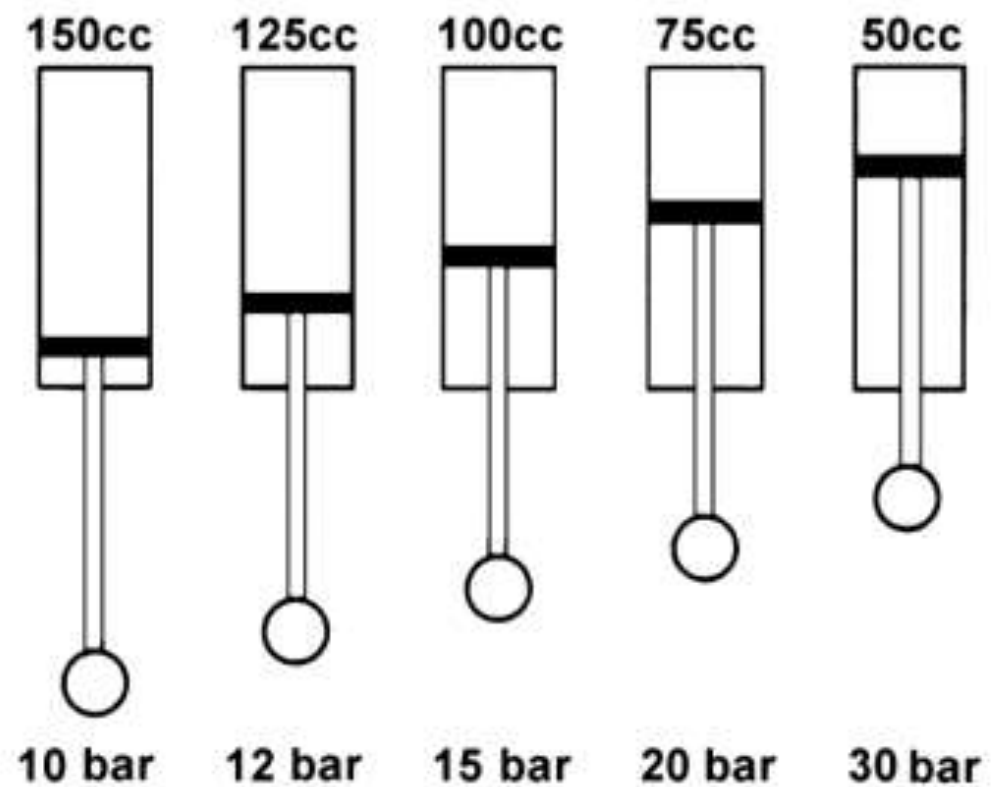
The Working of a Gas Spring



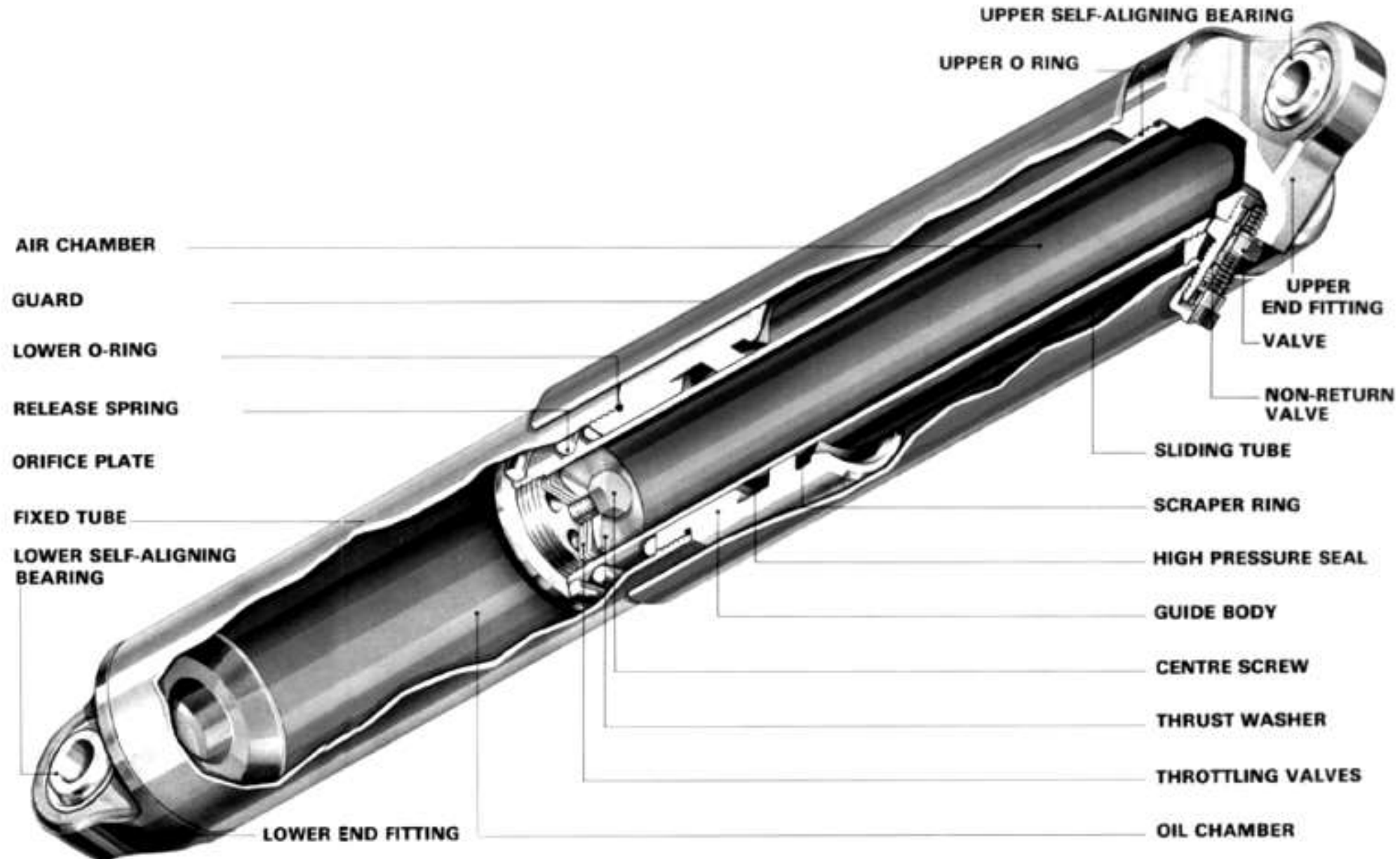
Unit with 5:1 compression ratio



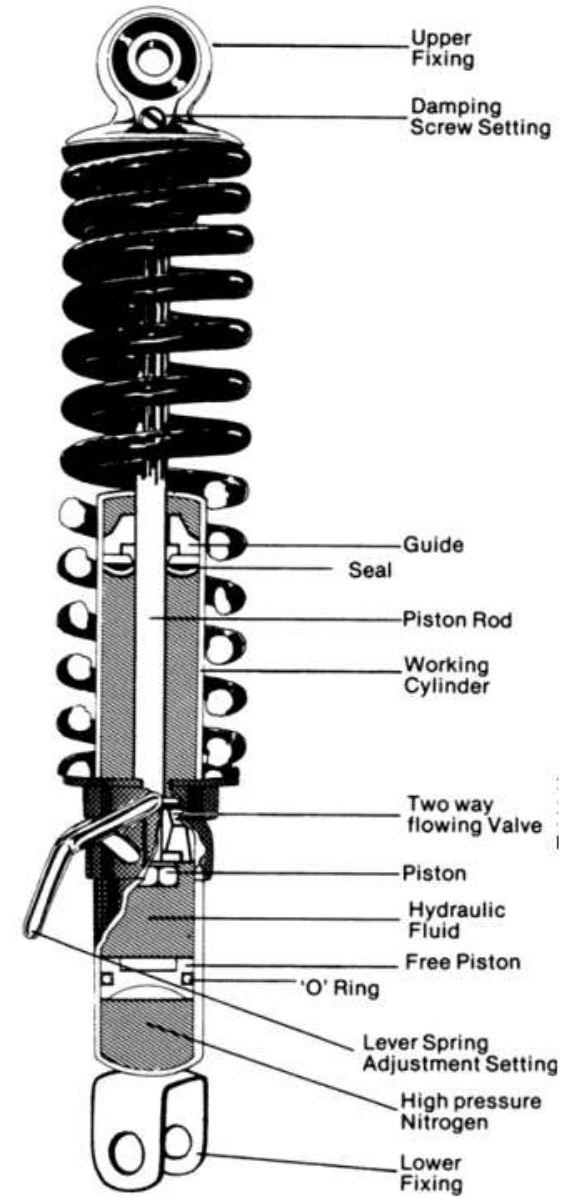
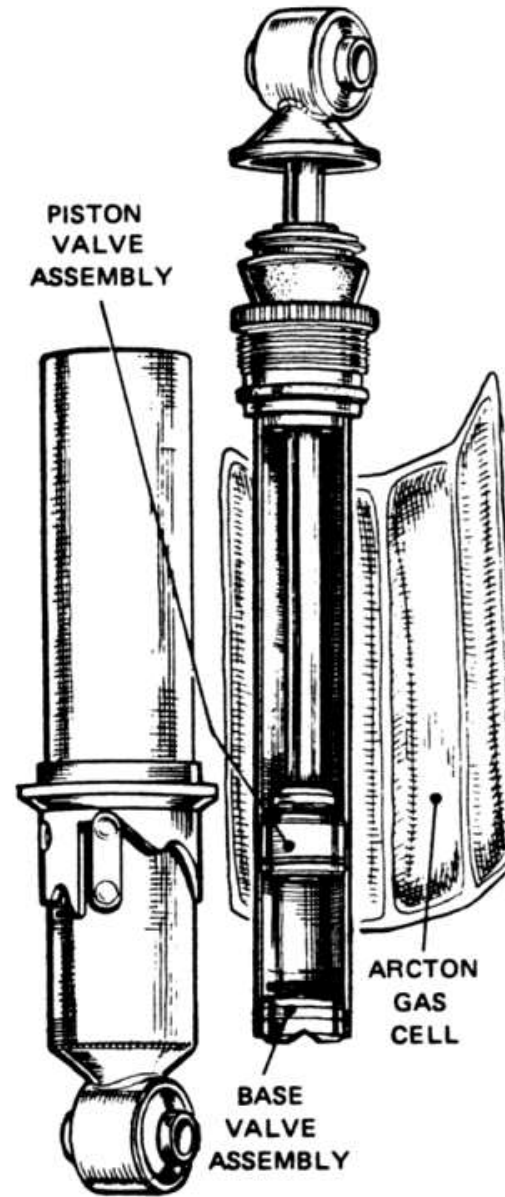
Unit with 3:1 compression ratio



- **Gas suspension strut**



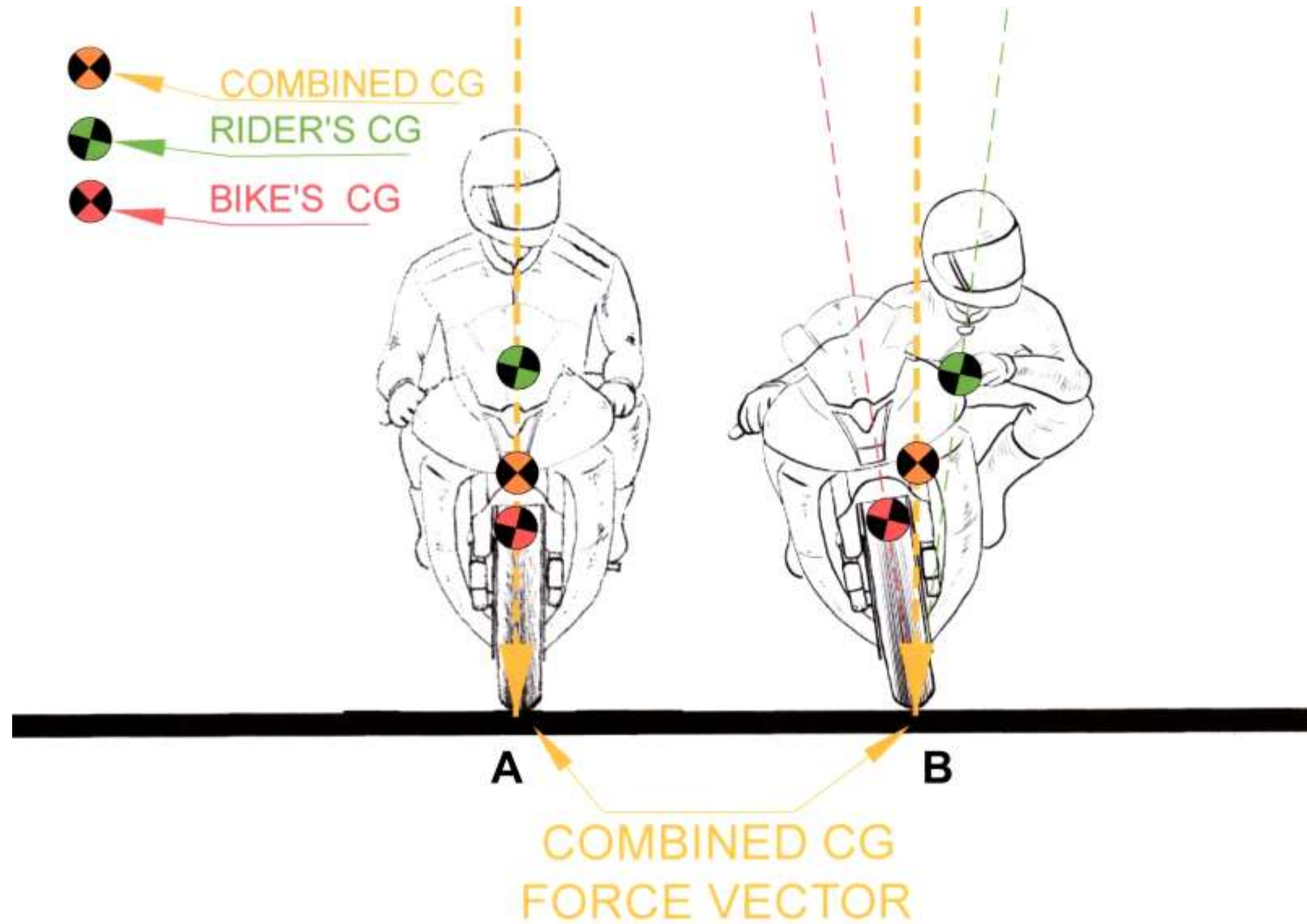
- **Damper** (Shock absorber) A damper slows and controls spring action. Dampers control spring action using hydraulic fluid, which travels through a series of passages and restrictions.
- A piston with a precisely measured passage (orifice) travels within the shock body in a bath of hydraulic fluid. The weight of the fluid and the size of the passage determines the piston's travel speed. When a motorcycle encounters a bump, dampers slow spring compression and rebound as the fluid slowly travels through the passages within the shock body.

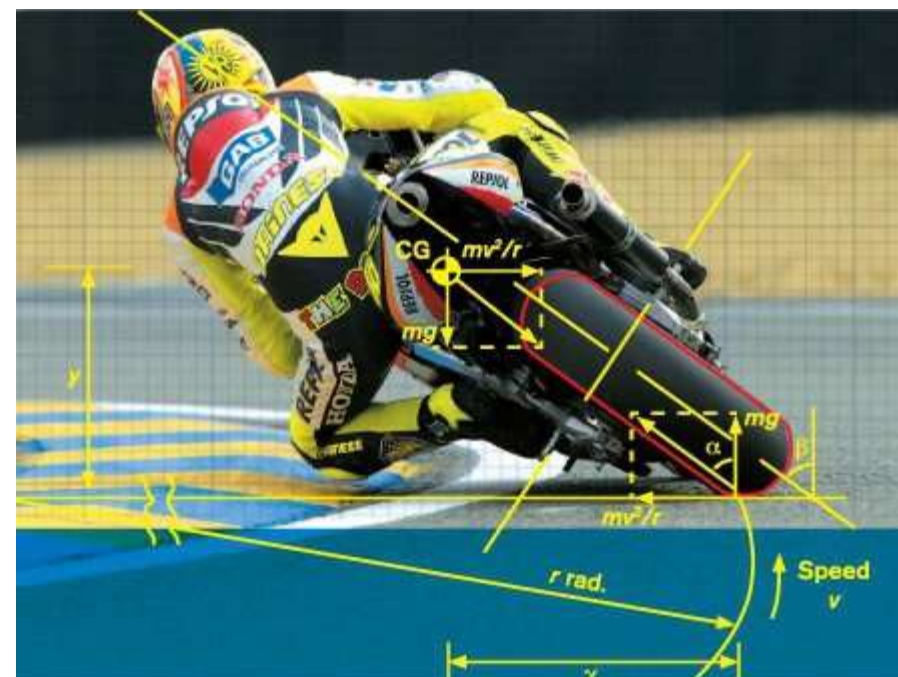


- **Dampers** play a vital role in the ride and handling of your car. Aside from giving you a comfortable ride, dampers help manage a vehicle's stability, cornering, handling, traction, braking, stopping distance, and overall safety.

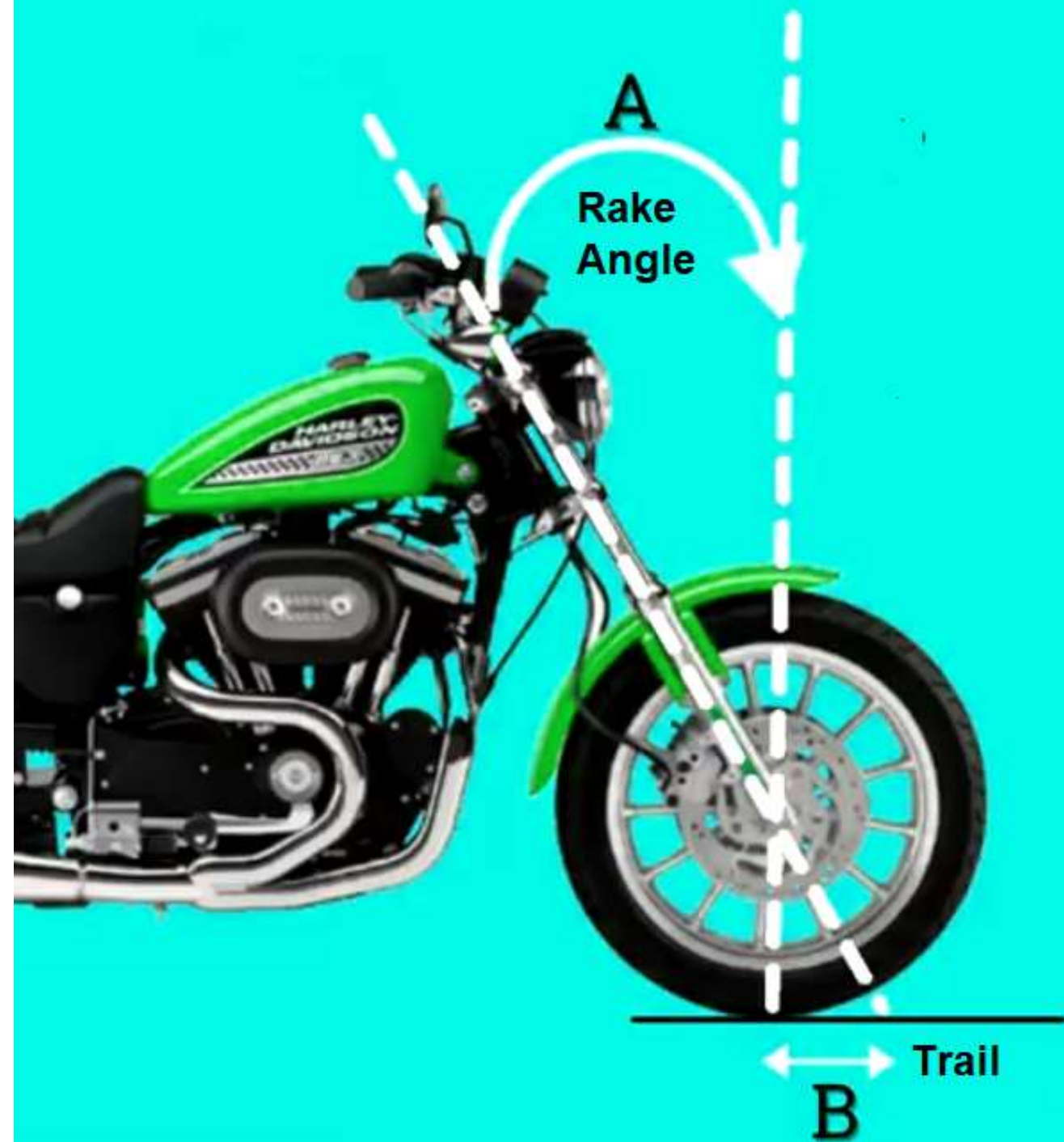


- **Suspension Geometry**

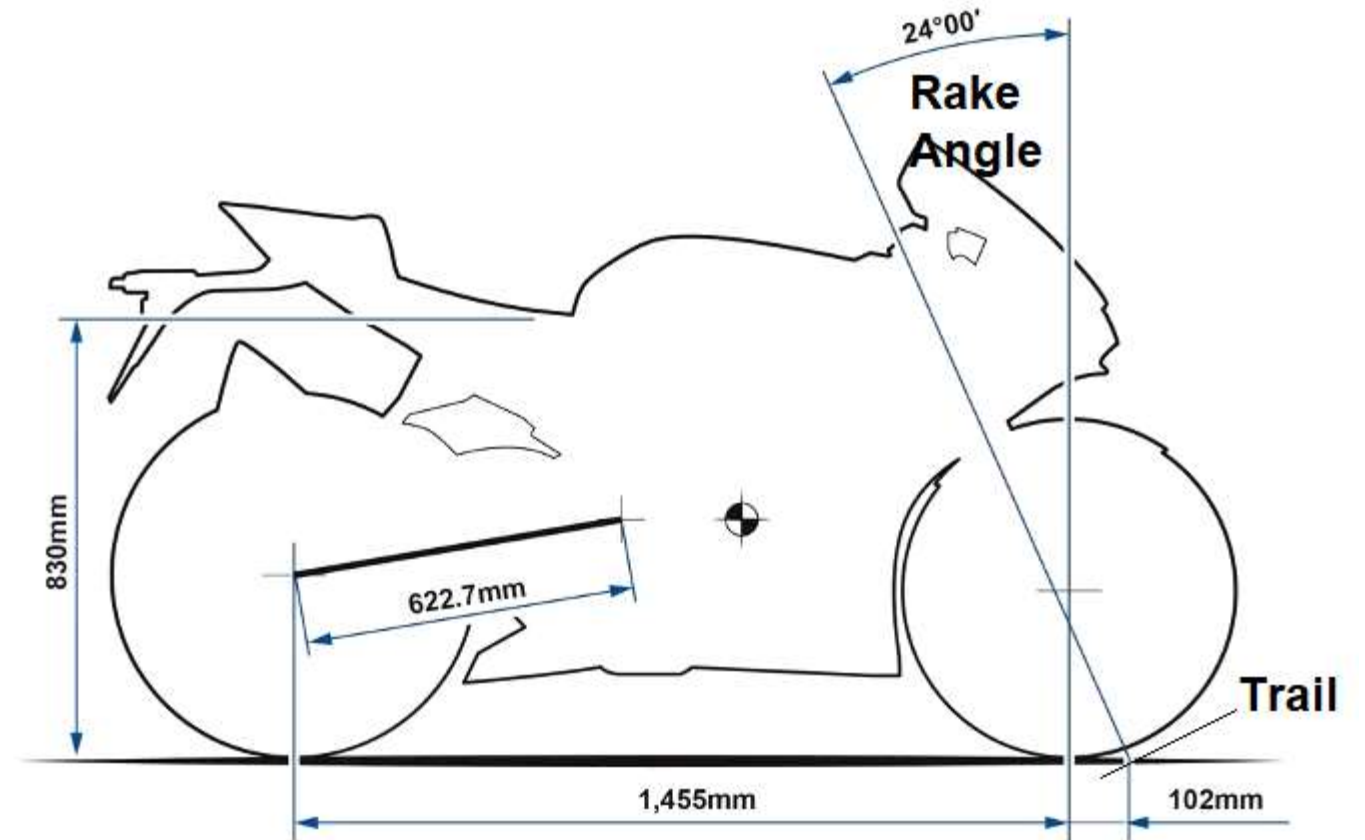




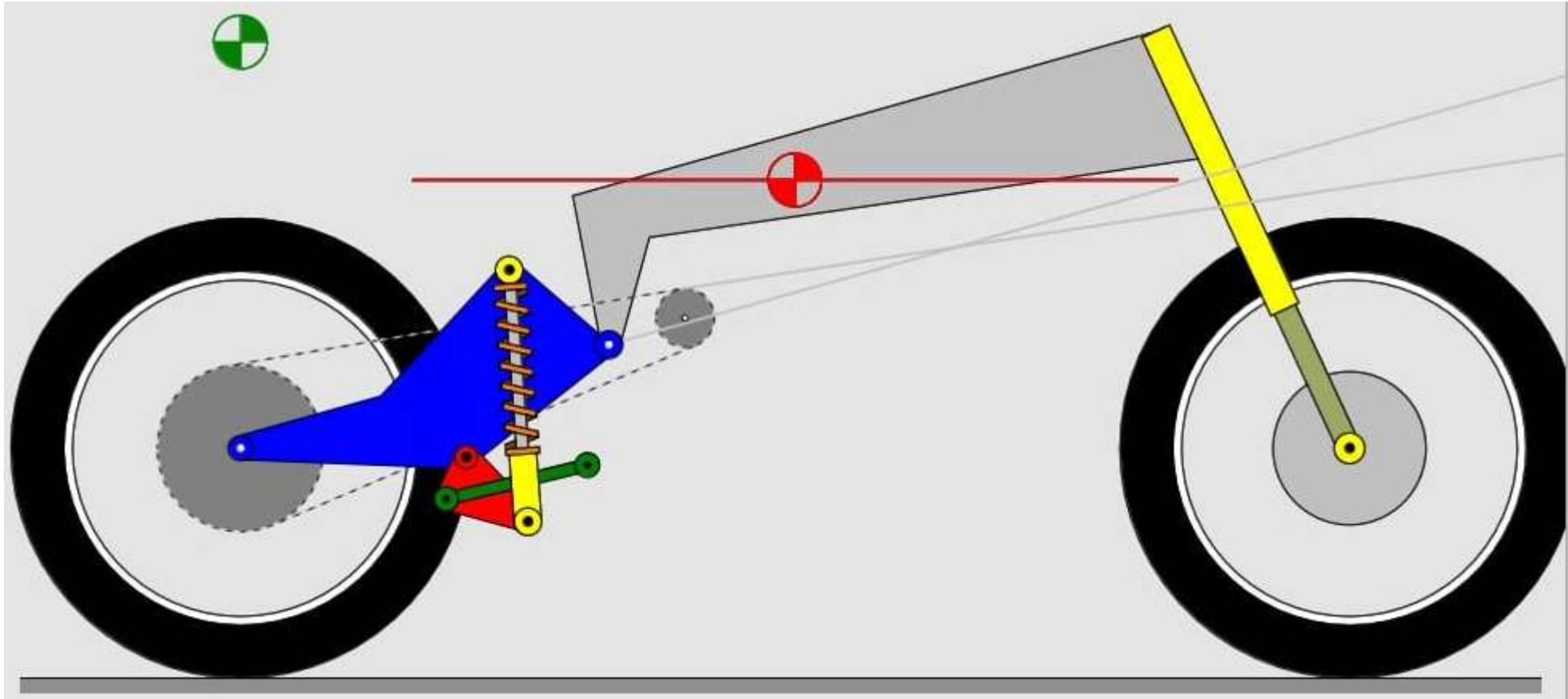
- **Rake and Trail**
- **Rake:** The distance, from our imaginary vertical line (above the front wheel) to our diagonal fork line is rake, again see diagram, this is measured in degrees. **Trail:** Below the front wheel spindle, you'll notice the lines have been carried onto the ground.



- the more rake and trail we have, the more stable the bike will become, although both steering and maneuverability may suffer for it. Conversely, when rake and trail are reduced, the bike will steer quicker and become more maneuverable, though it's usually at the expense of stability

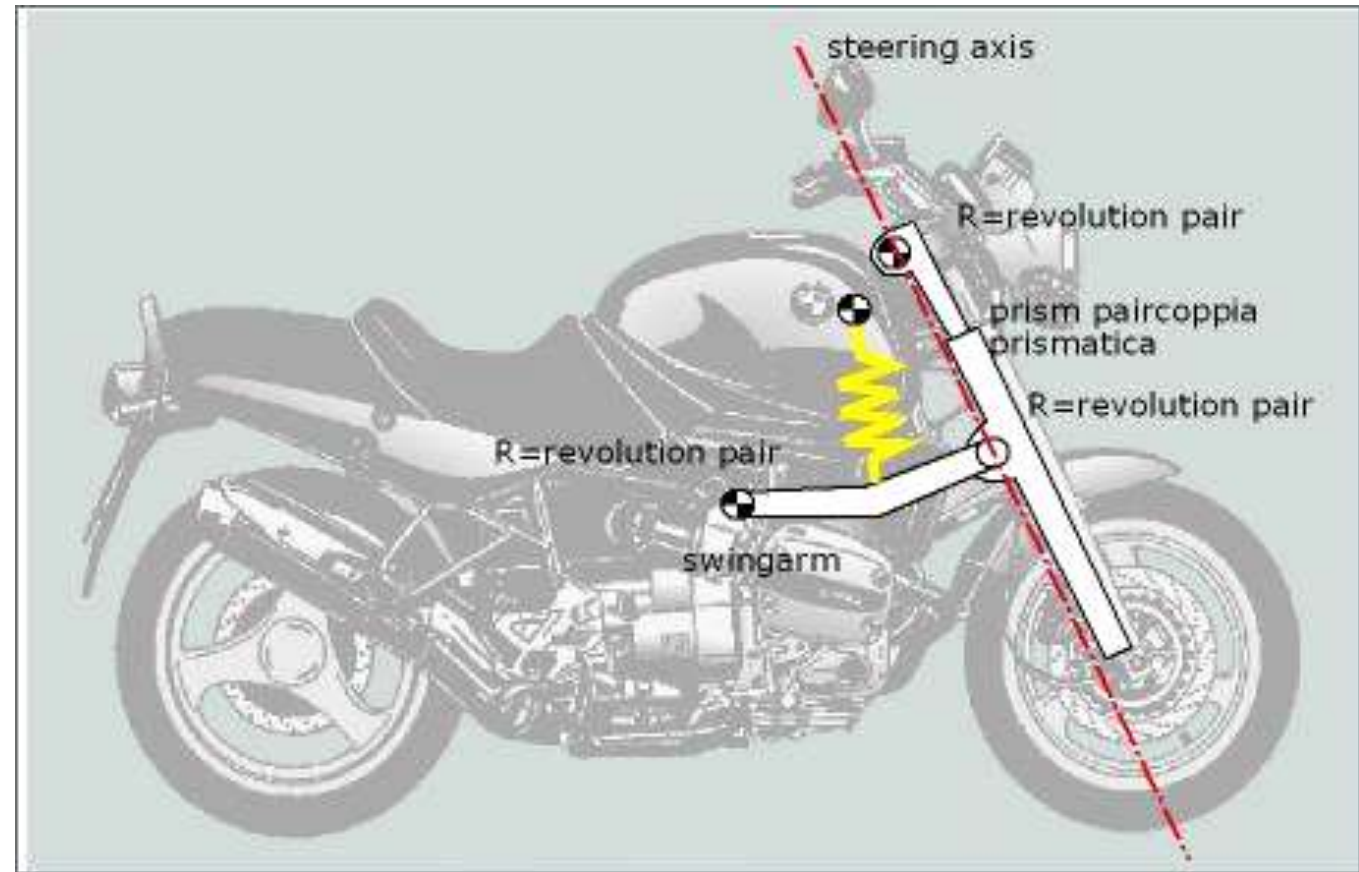


- **Motorcycle Suspension** Motorcycle suspensions use a spring and damper combination to isolate the chassis and rider from road imperfections. On-road motorcycle suspension systems work to minimize the effect of potholes, bumps, cornering and acceleration/deceleration forces

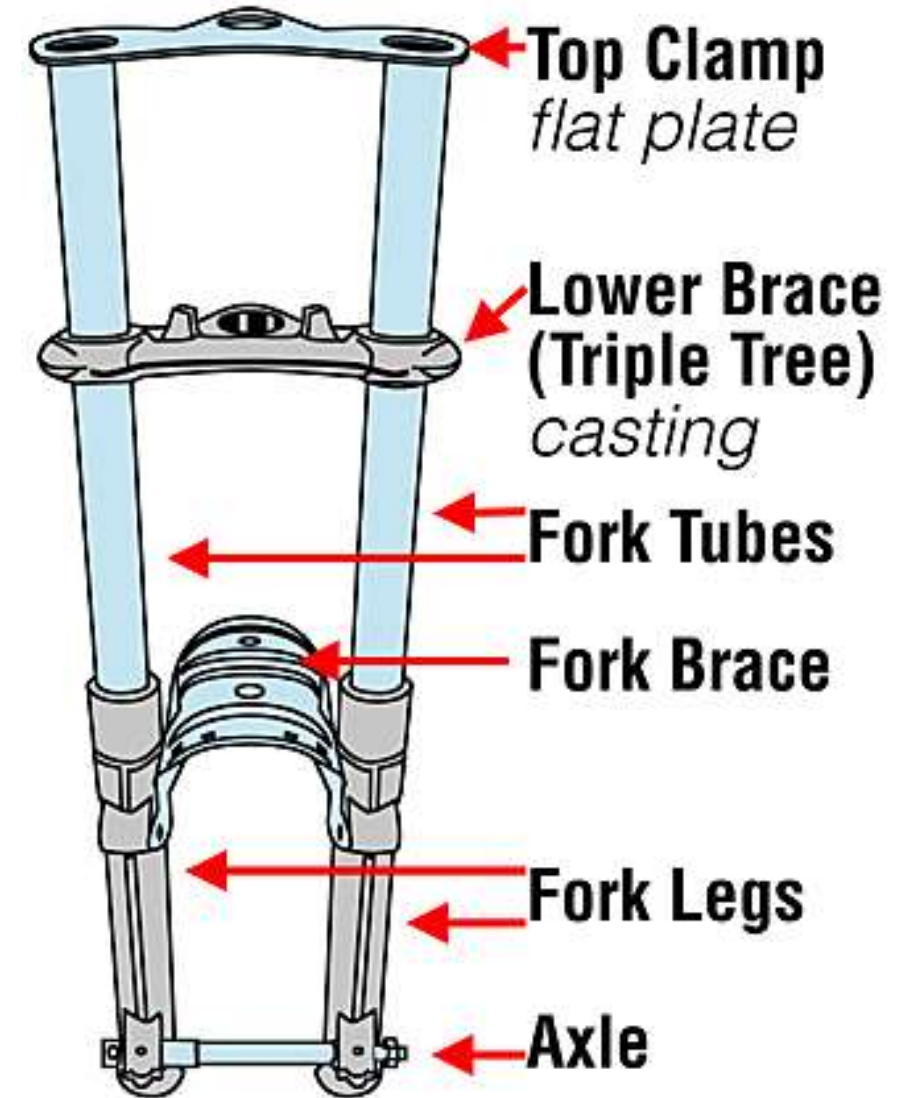


Front Suspension

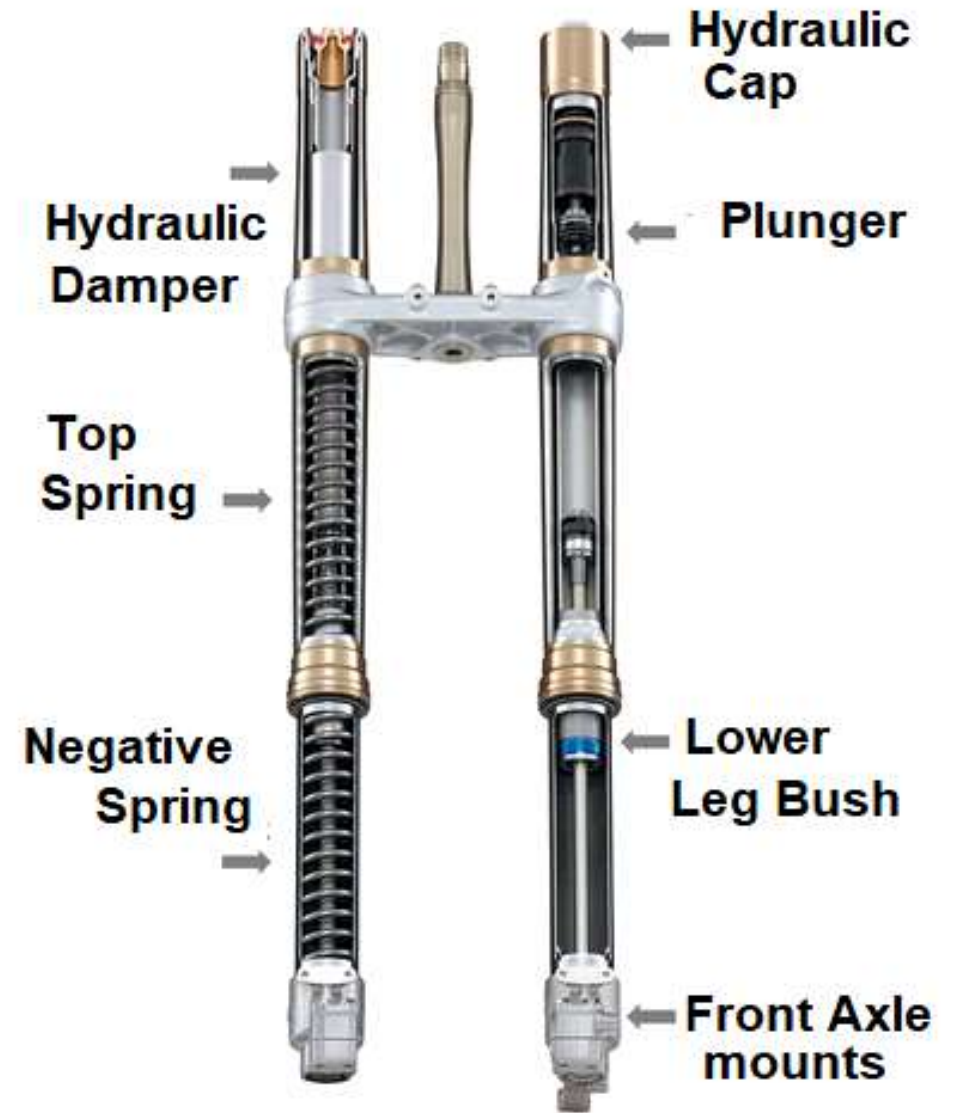
- motorcycles use suspension forks. In some systems, both springs and dampers work together within each fork leg. In others, one leg contains the spring and the other contains the damper (separate function forks).



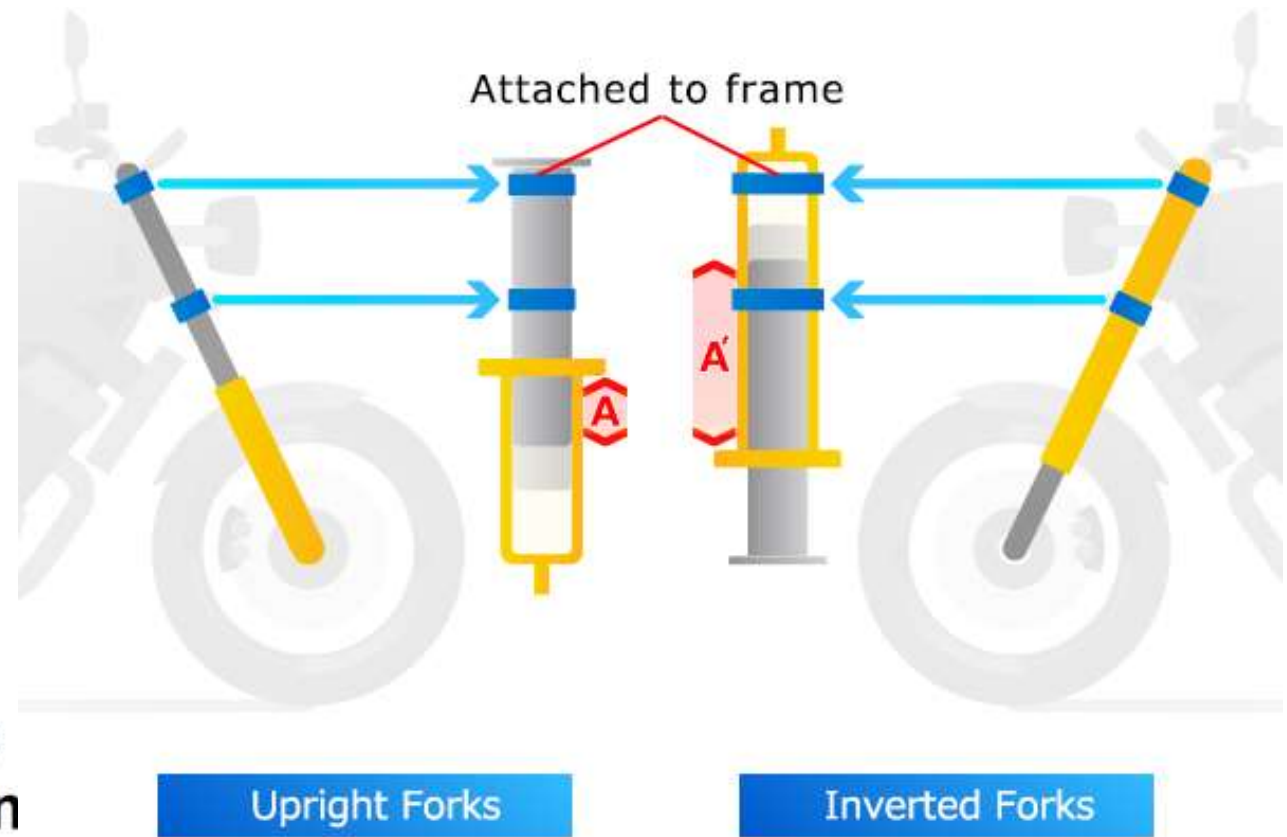
- **Telescopic Forks** A motorcycle fork connects a motorcycle's front wheel and axle to its frame, typically via a yoke, also known as a triple clamp, which consists of an upper yoke joined to a lower yoke via a steering stem, a shaft that runs through the steering head, creating the steering axis.



650 mm Front Fork Cross-country motorbike



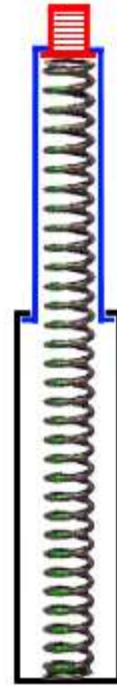
- **Upside-down" (USD) forks**, also known as inverted forks, are installed inverted compared with conventional telescopic forks.



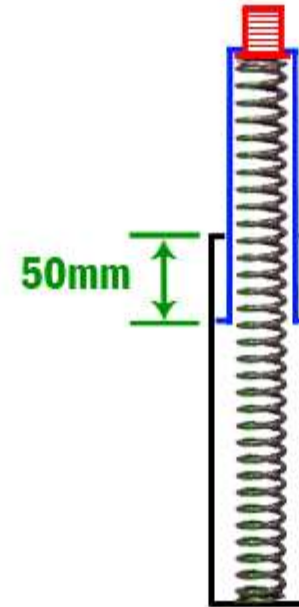
Pre-load adjustment

- Preload is used to adjust the shock or spring to the correct range of operation within the suspension's travel-more preload will raise the bike up on its suspension, keeping you near the top of its travel. With less preload, the bike sits lower and closer to the bottom of its suspension travel.

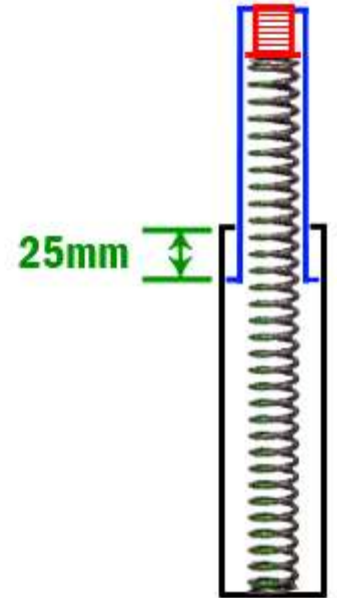
Unladen Fork



Fork Under 50kg Weight



Fork Under 50kg Weight (Plus 25mm Preload)



Wheel off
ground
Forks fully
extended

Weight of bike
only - distance
cable tie has
moved is
Bike Sag

Weight of rider
& bike - distance
cable tie has
moved is
Rider Sag



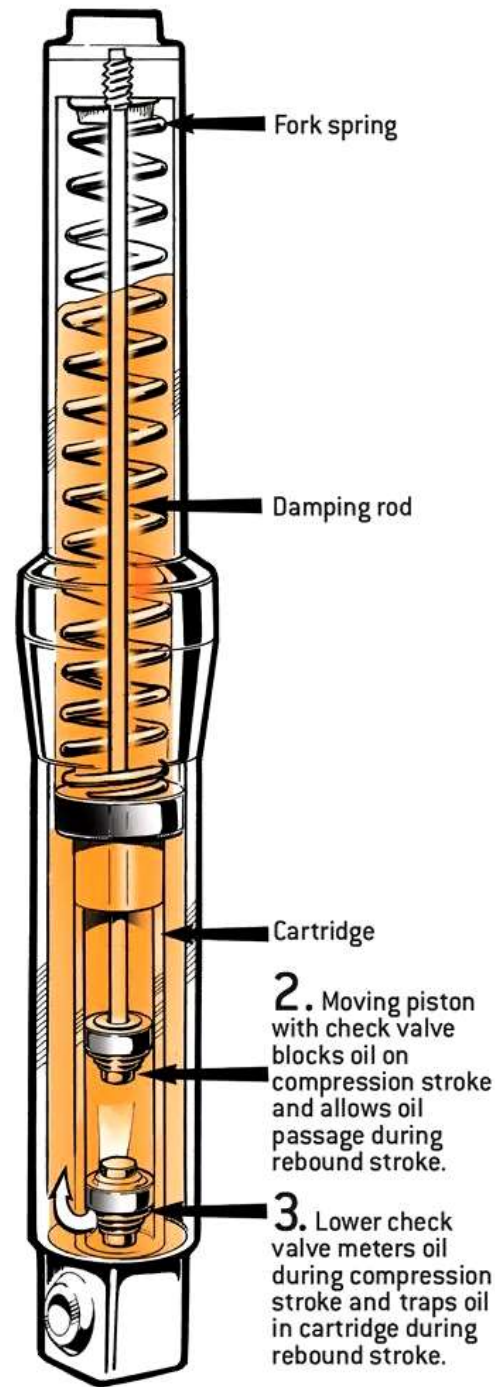
Fork Damping

- Compression damping controls the force that moves a fork or shock through its travel, using oil. This oil circulates through a compression circuit that's designed to restrict its flow. Restricting the oil's flow makes the suspension feel firmer, causing it to compress and extend more slowly

Key Point:
This system
isolates the
damping
function
from air
contamination.



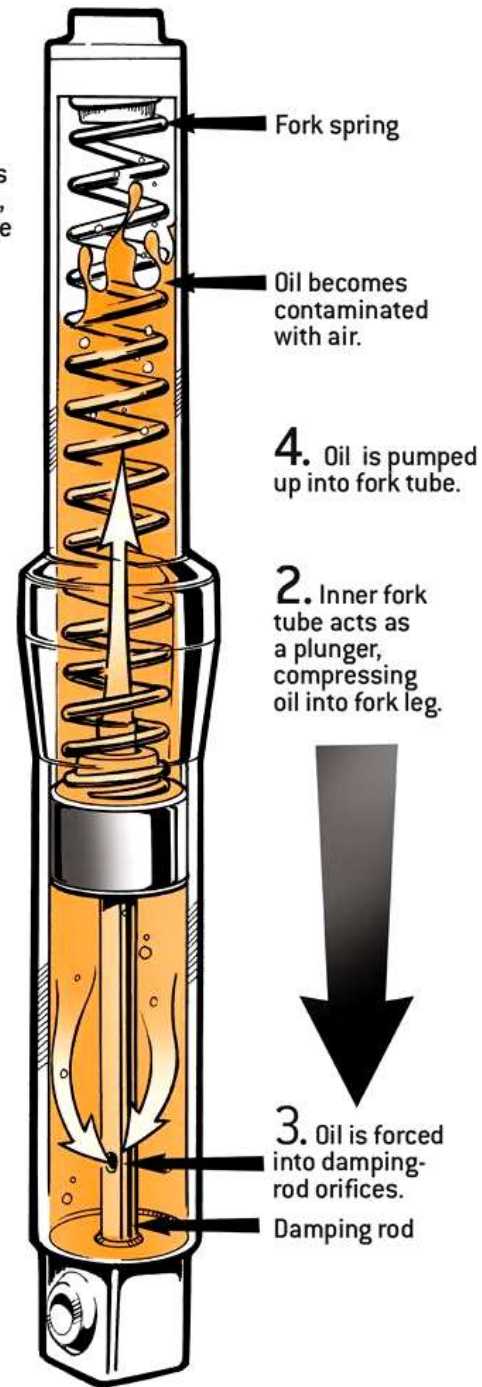
1. Outer fork tube is driven up by road surface.



Key Point:
This system promotes
an air and oil mixture,
creating unpredictable
performance.

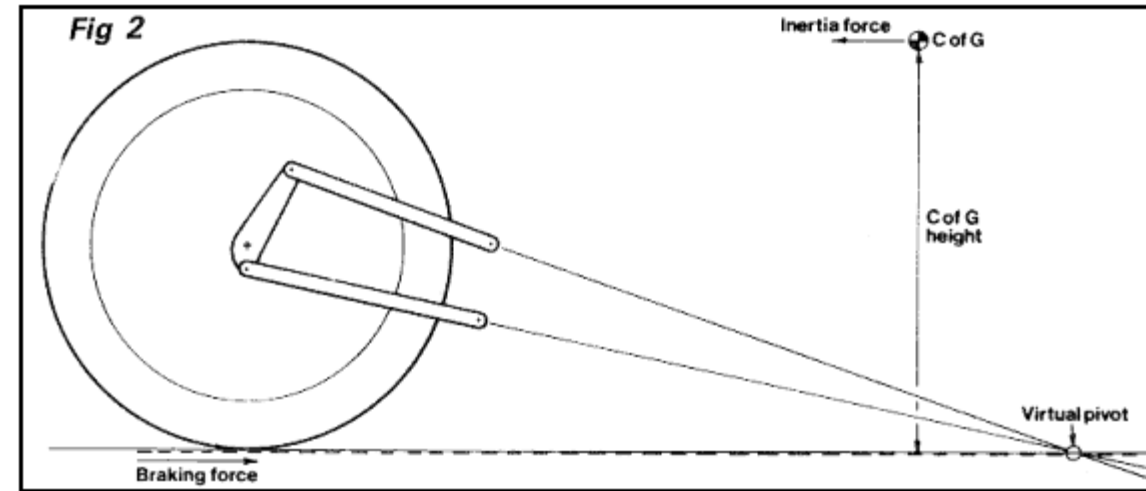
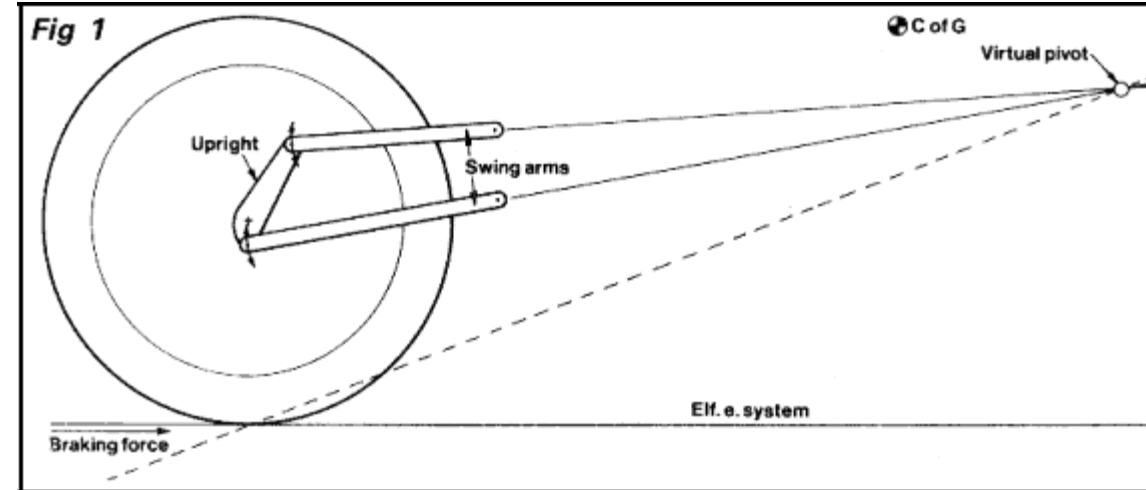


1. Outer fork tube is driven up by road surface.

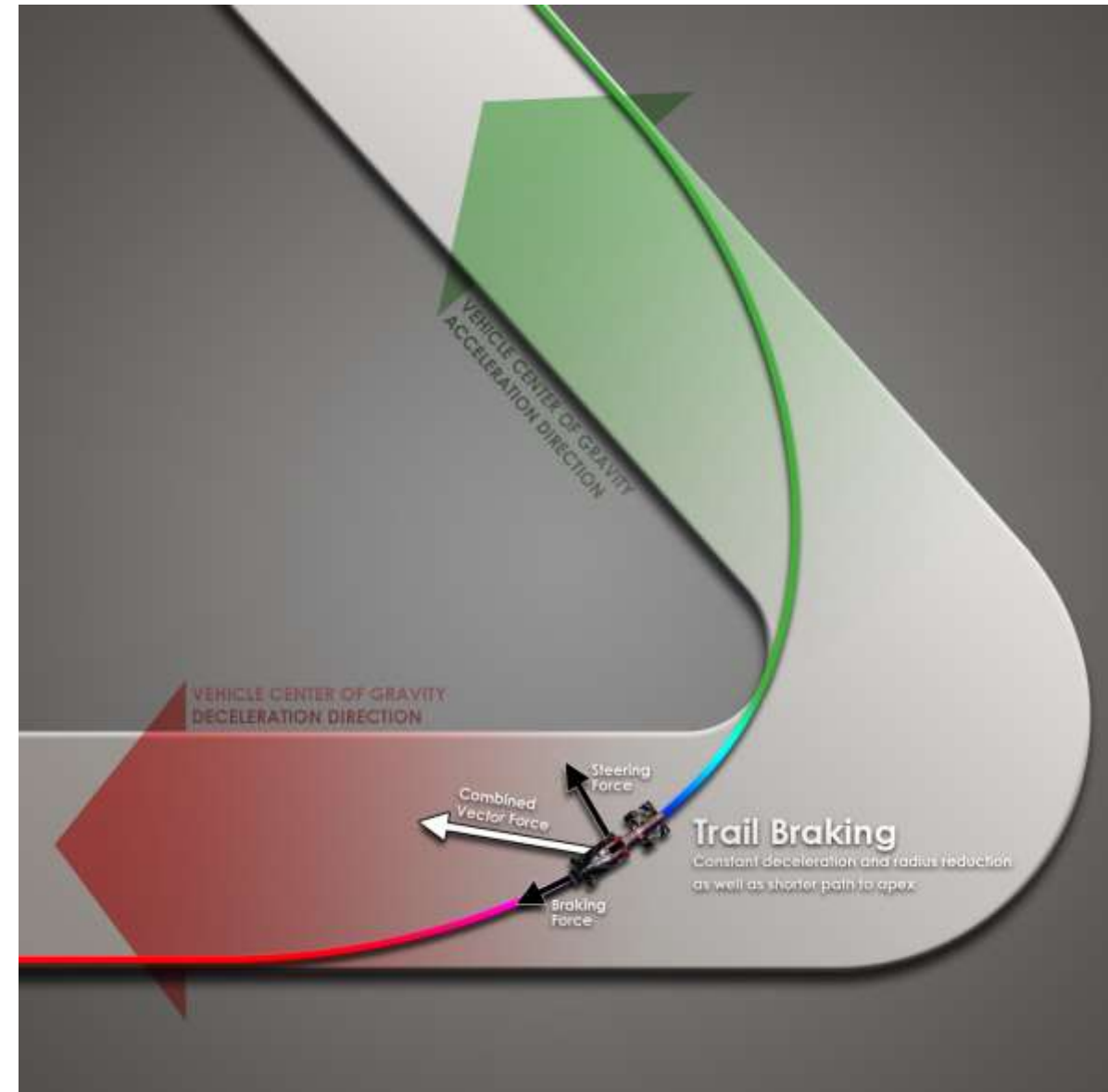


- **Brake dive:** Brake dive happens due to a phenomenon called load transfer. And that's happen when applying the brakes of a moving motorcycle increases the load borne by the front wheel and decrease the load borne by the rear wheel due to a phenomenon called load transfer.



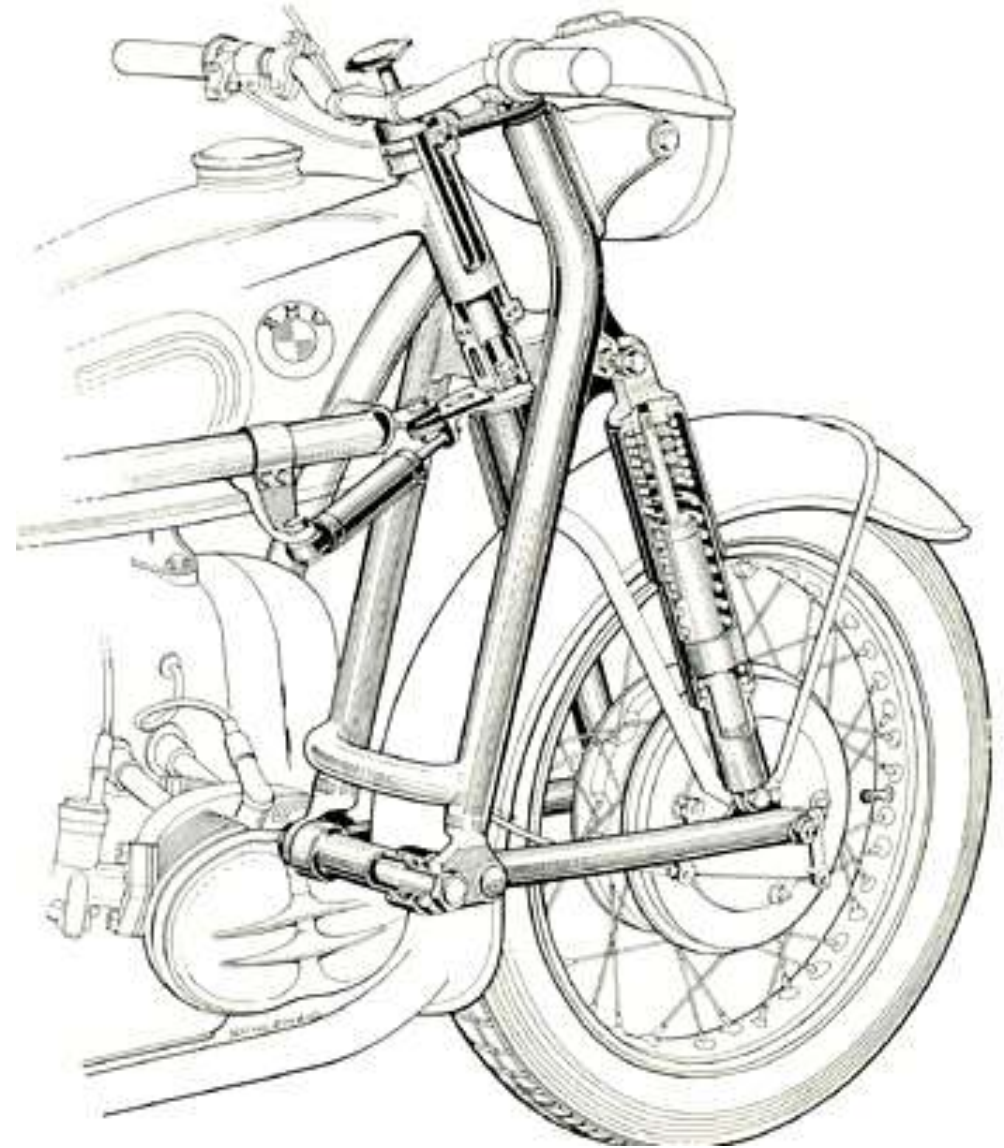


- **Trail braking** is a driving and motorcycle riding technique where the brakes are used beyond the entrance to a turn (turn-in), and then gradually released (trailed off)



Earles

- The **Earles fork** is a variety of leading link fork where the pivot point is behind the front wheel, This arrangement construction is much stronger than teleforks, especially against lateral deflection caused by hard cornering



Earles



- **Saxon-Motodd (Telelever) fork**



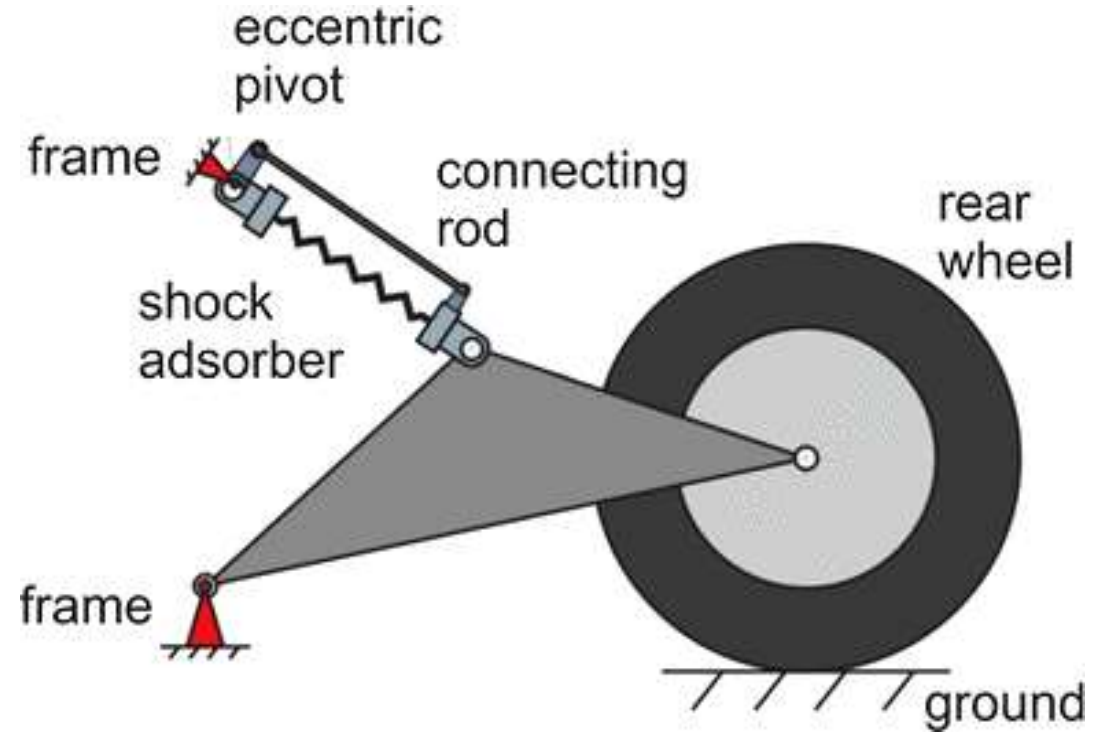
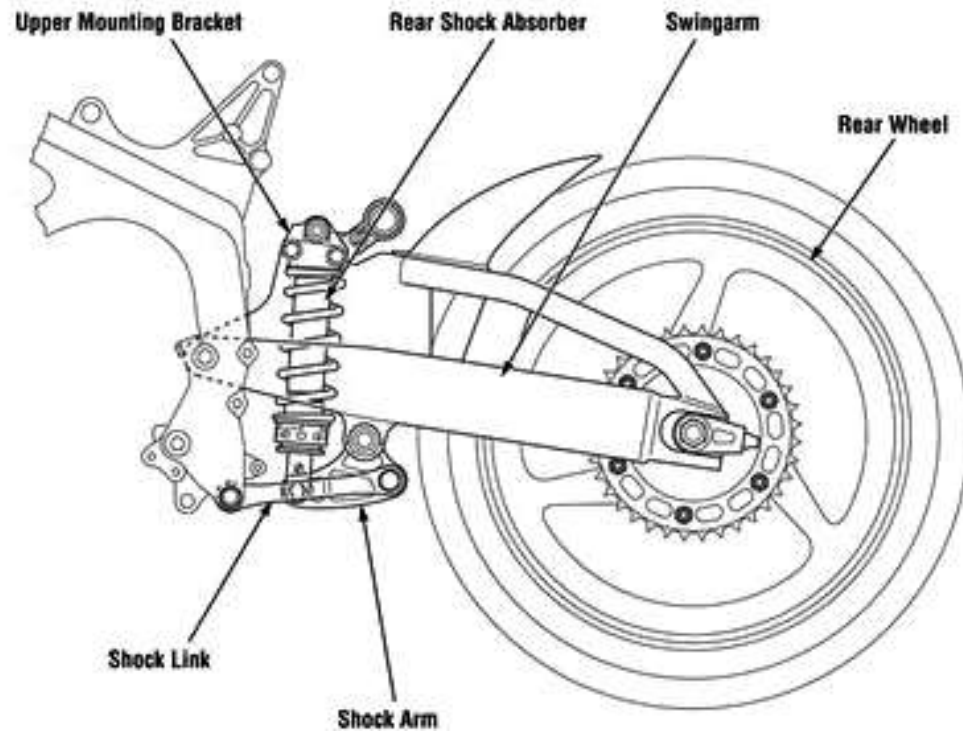
- **Hossack/Fior (Duolever) fork**



- **Single-sided**

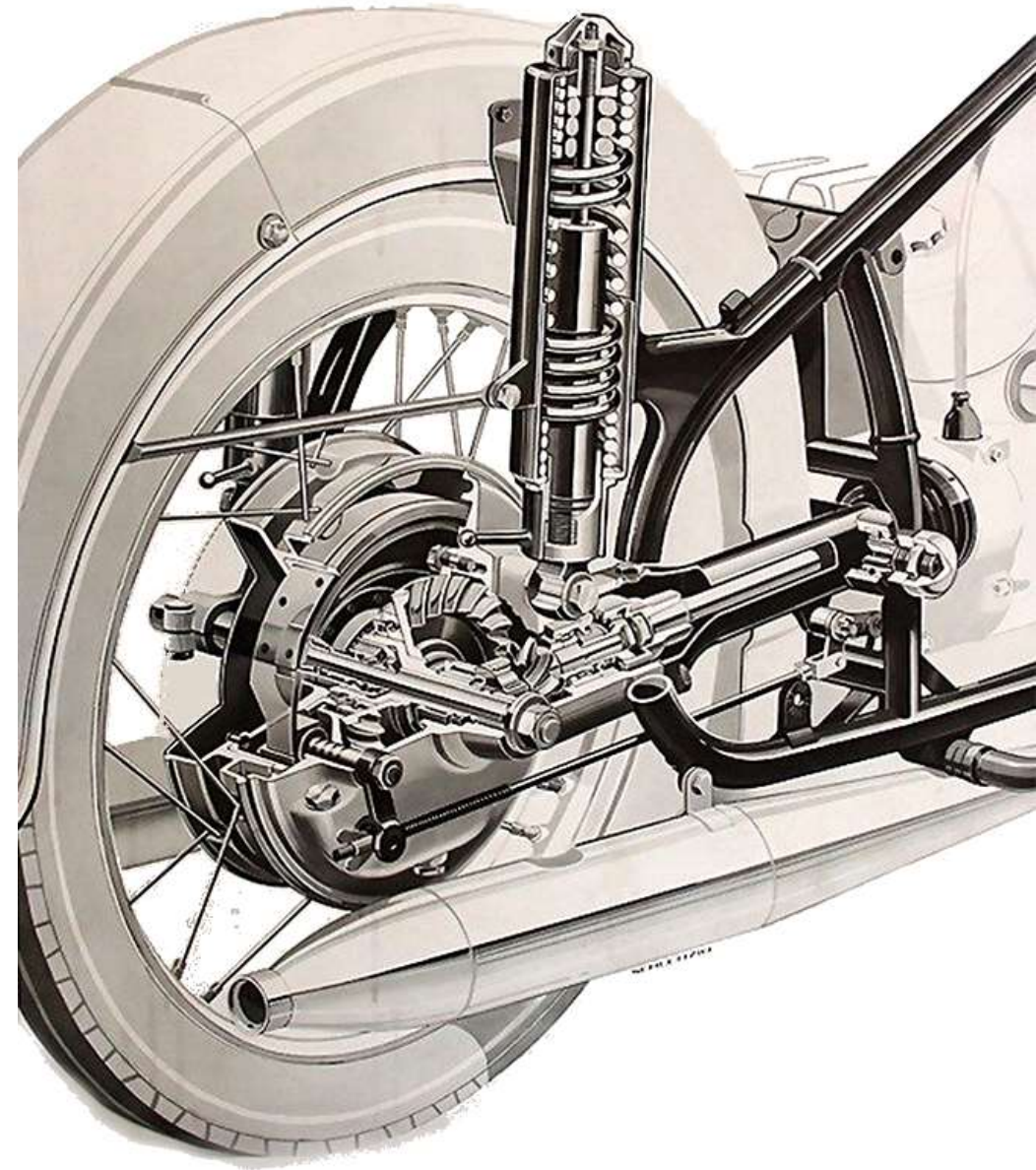


Motorcycle Rear Suspension



Plunger suspension

- Several motorcycles before and immediately after World War II used plunger suspension in which the vertical movement of the rear axle was controlled by plungers suspended by springs





- A **swingarm** originally known as a swing fork or pivoted fork, is a single or double sided mechanical device which attaches the rear wheel of a motorcycle to its body, allowing it to pivot vertically.





- **Shock absorbers**
A **shock absorber** or **damper** is a mechanical or hydraulic device designed to absorb and damp shock impulses. It does this by converting the kinetic energy of the shock into another form of energy (typically heat) which is then dissipated.

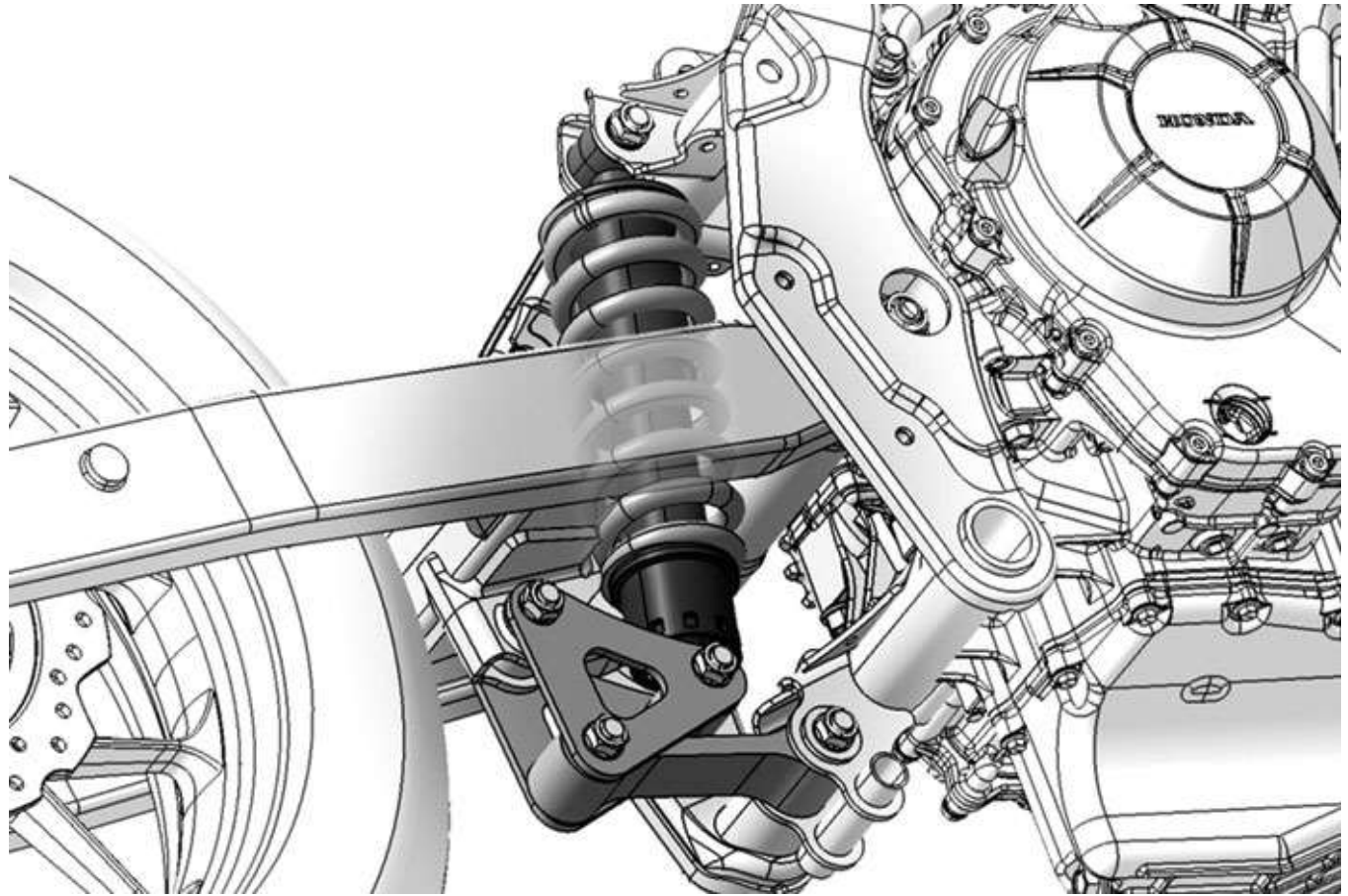


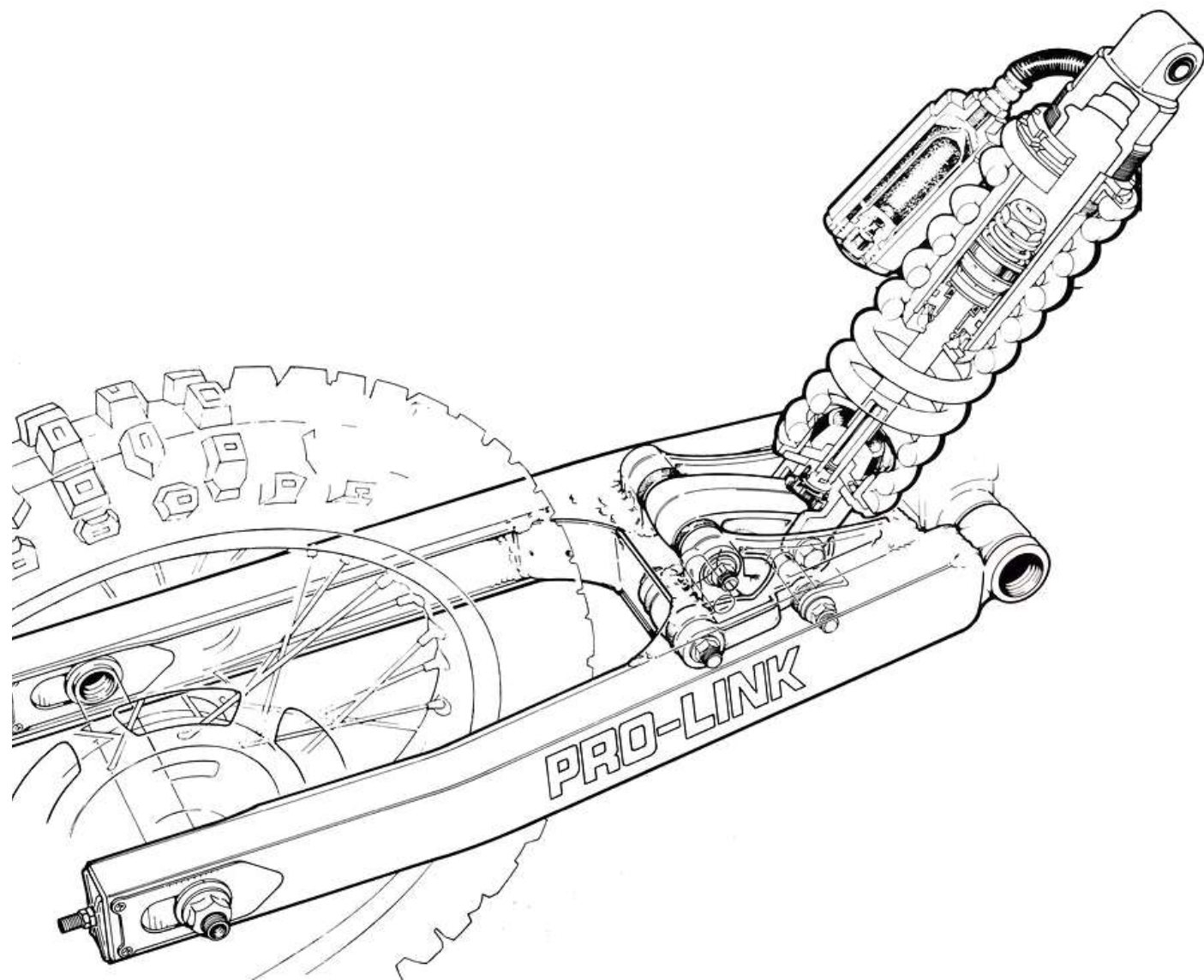
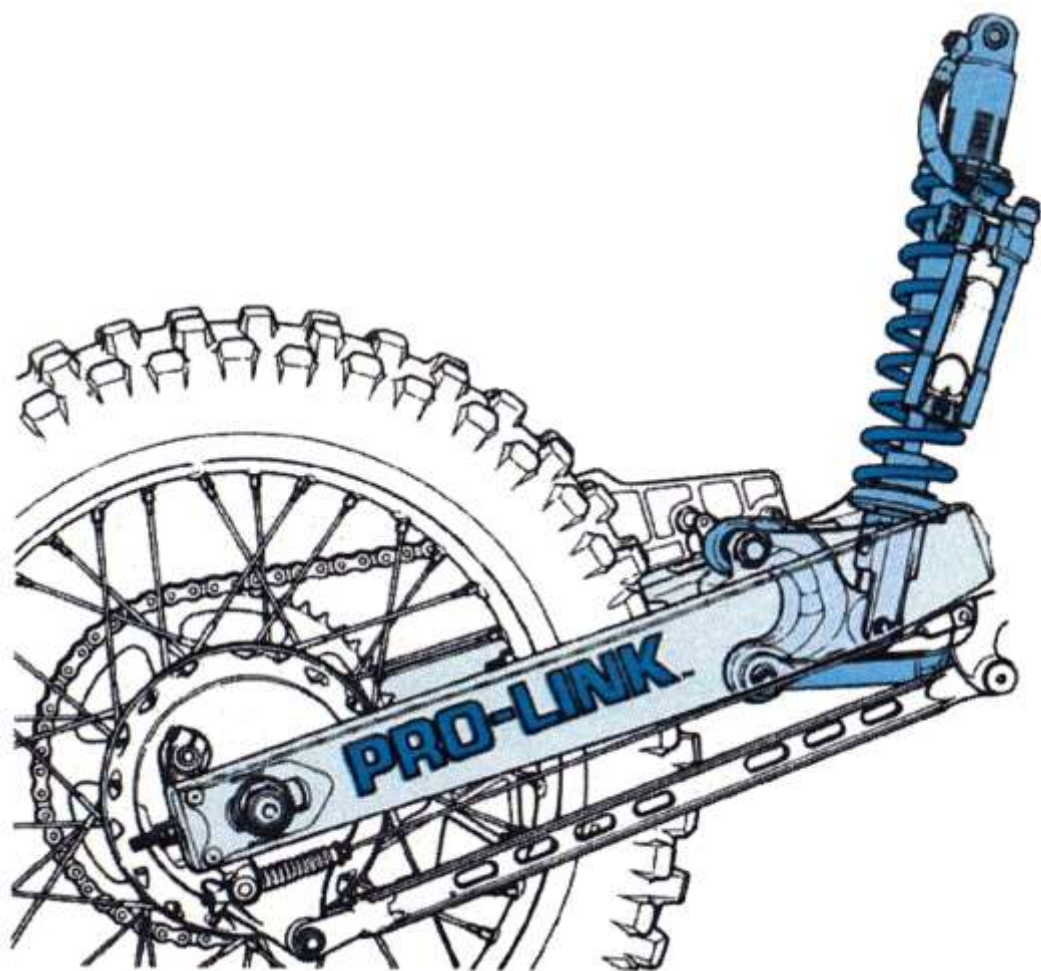
- ***Twin shock*** refers to motorcycles that have two shock absorbers.





- **Single shock absorber** On a motorcycle with a single shock absorber rear suspension, a single shock absorber connects the rear swingarm to the motorcycle's frame. Typically this lone shock absorber is in front of the rear wheel, and uses a linkage to connect to the swing arm.





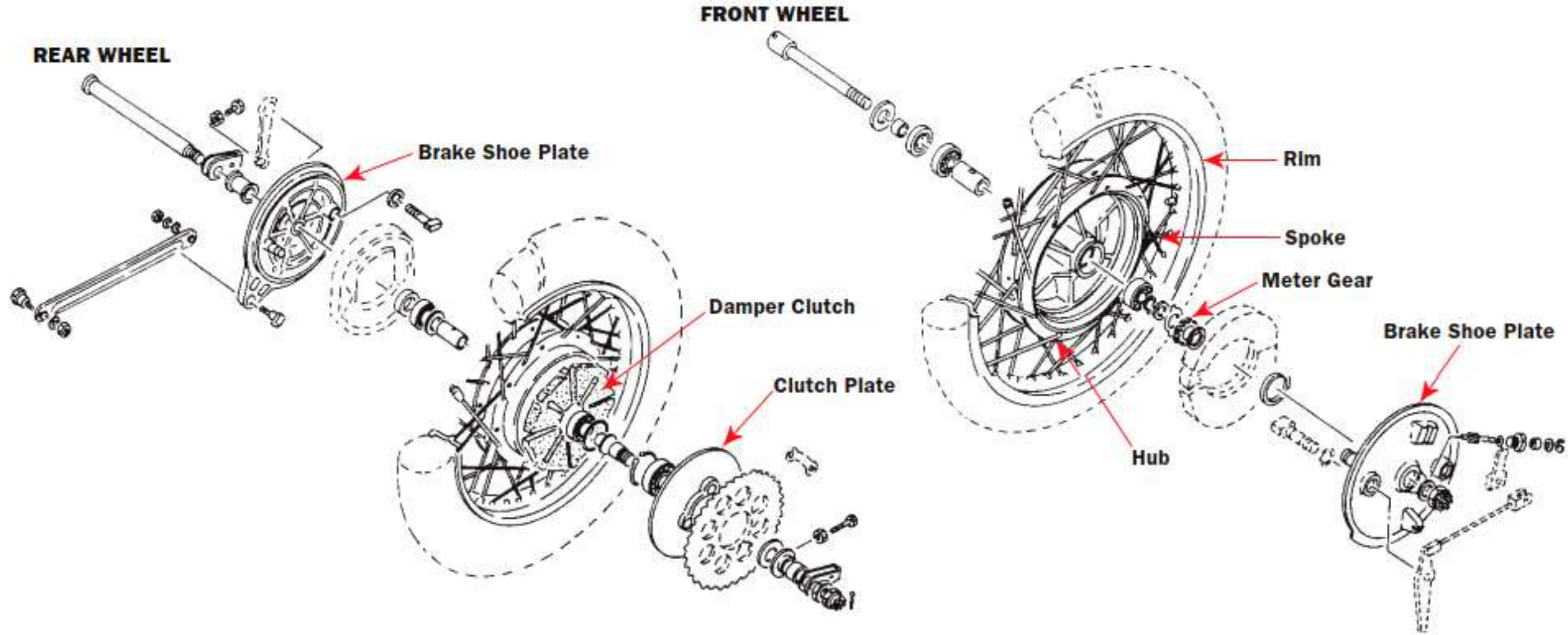
Wheels and Tires

The main functions of tires

- To support a vehicles weight.
- To transmit accelerating and braking force to the ground.
- To change/maintain direction.
- To absorb shock from the road surface



Wheel construction



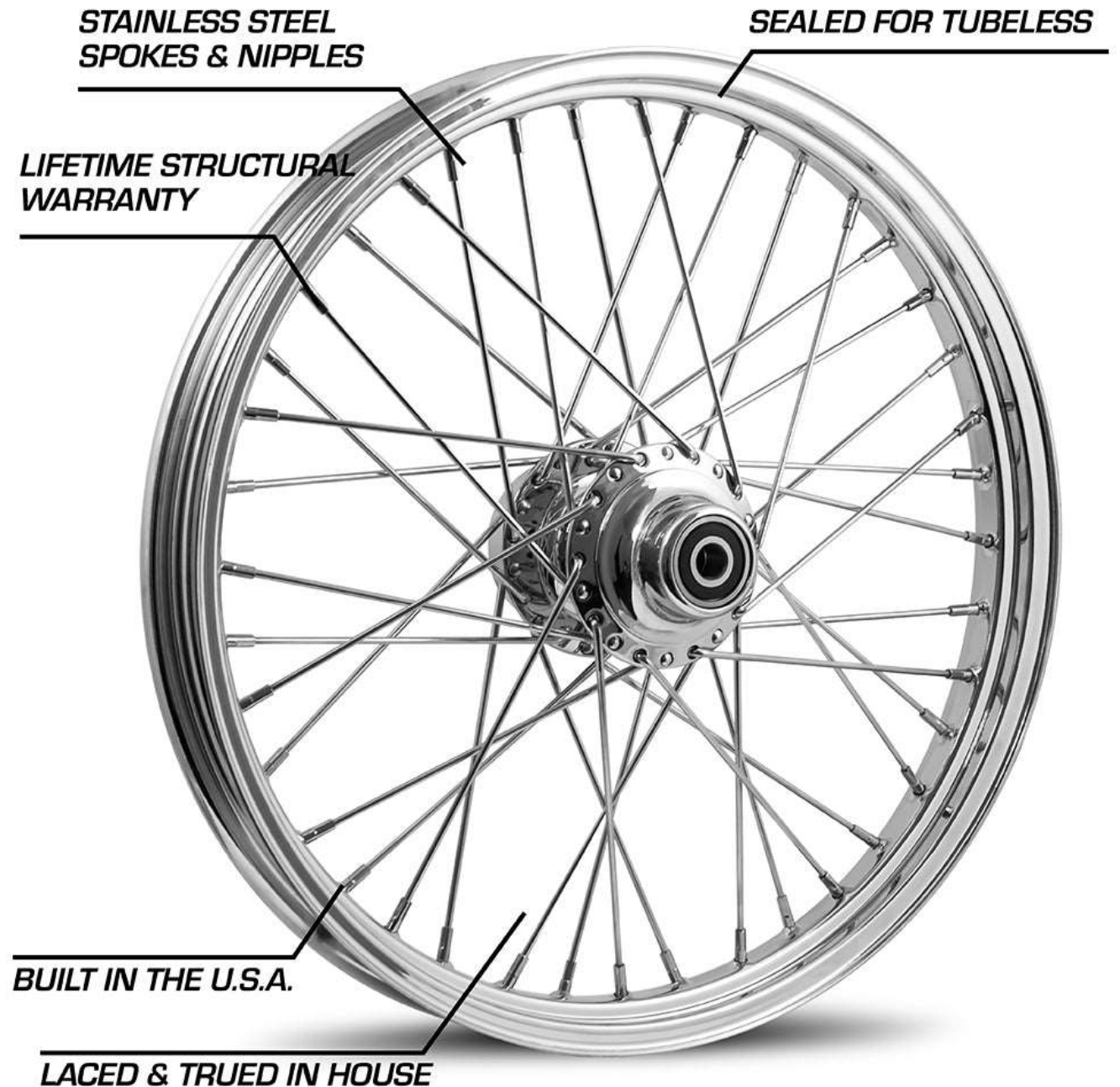
Aluminum alloy wheels

- Steering and handling is also often improved with alloy wheels. The lighter wheels also help limit wear and tear on other bike components, like the engine, transmission and suspension. Alloy wheels also permit better heat conduction and dissipation, which directly translates to better braking

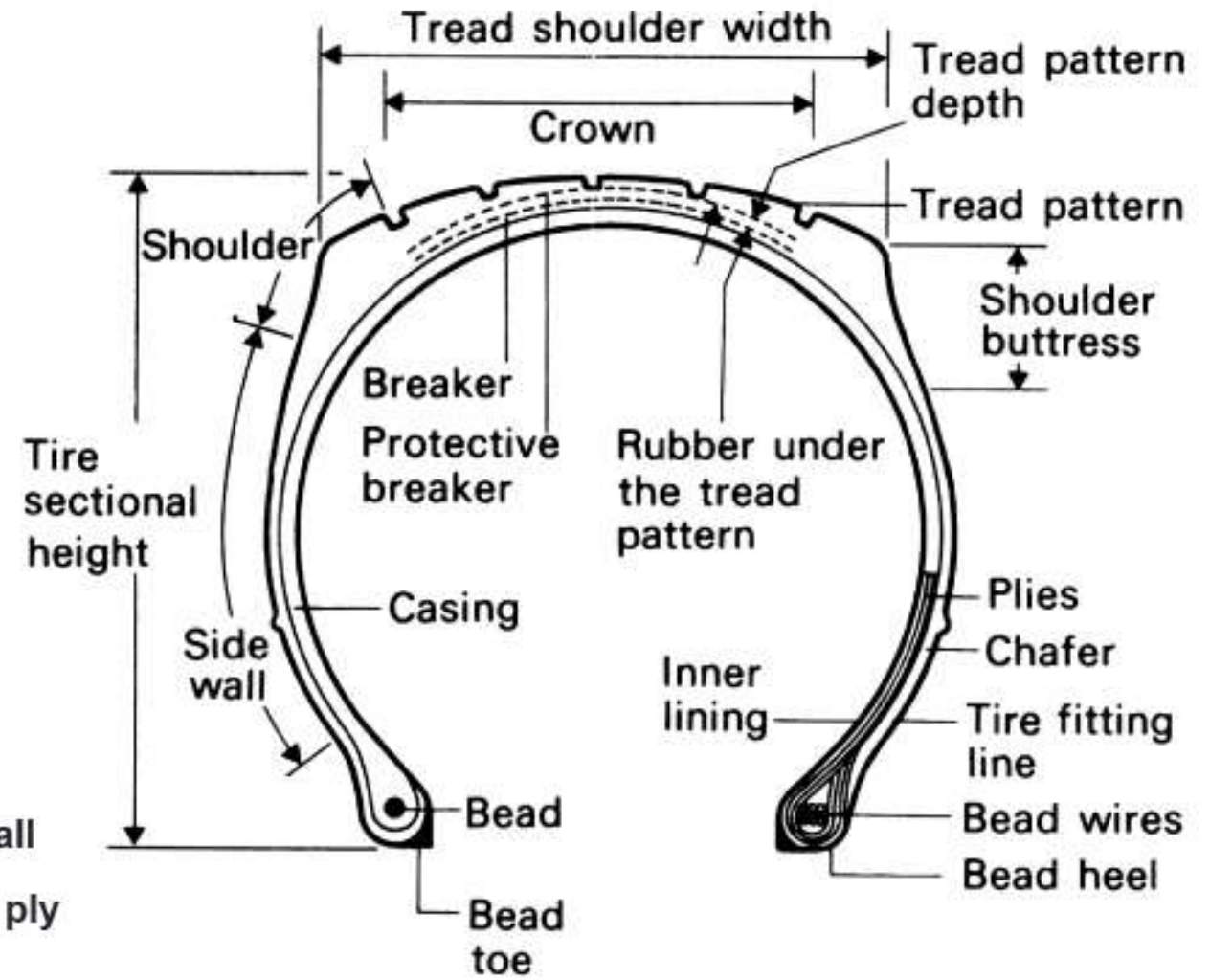


Wire spoke Wheels

- This is where spoked wheels come in: they are designed to bend, flex and handle impacts to a certain degree, letting you tackle rough terrains with ease. Spoked wheels are also easily repairable, as replacing individual parts is simple and inexpensive, unlike alloy wheels, which once cracked needs replacement.



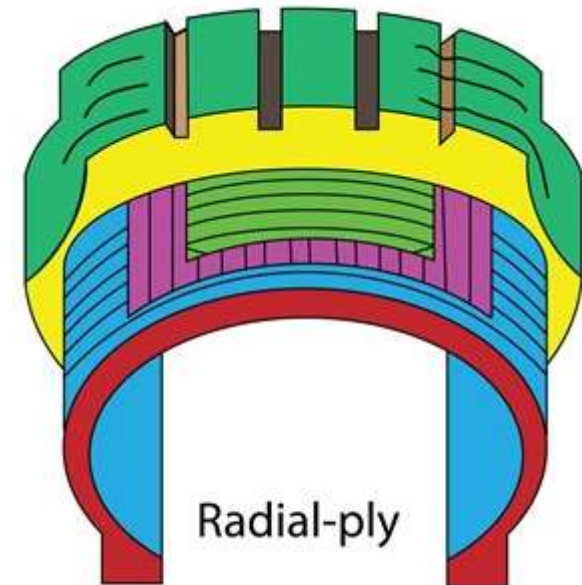
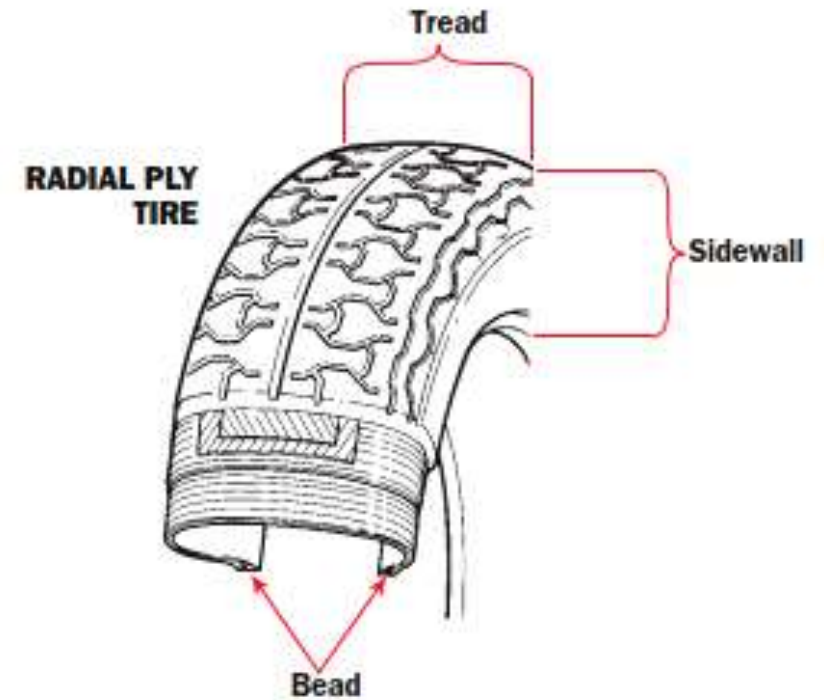
- Tires construction



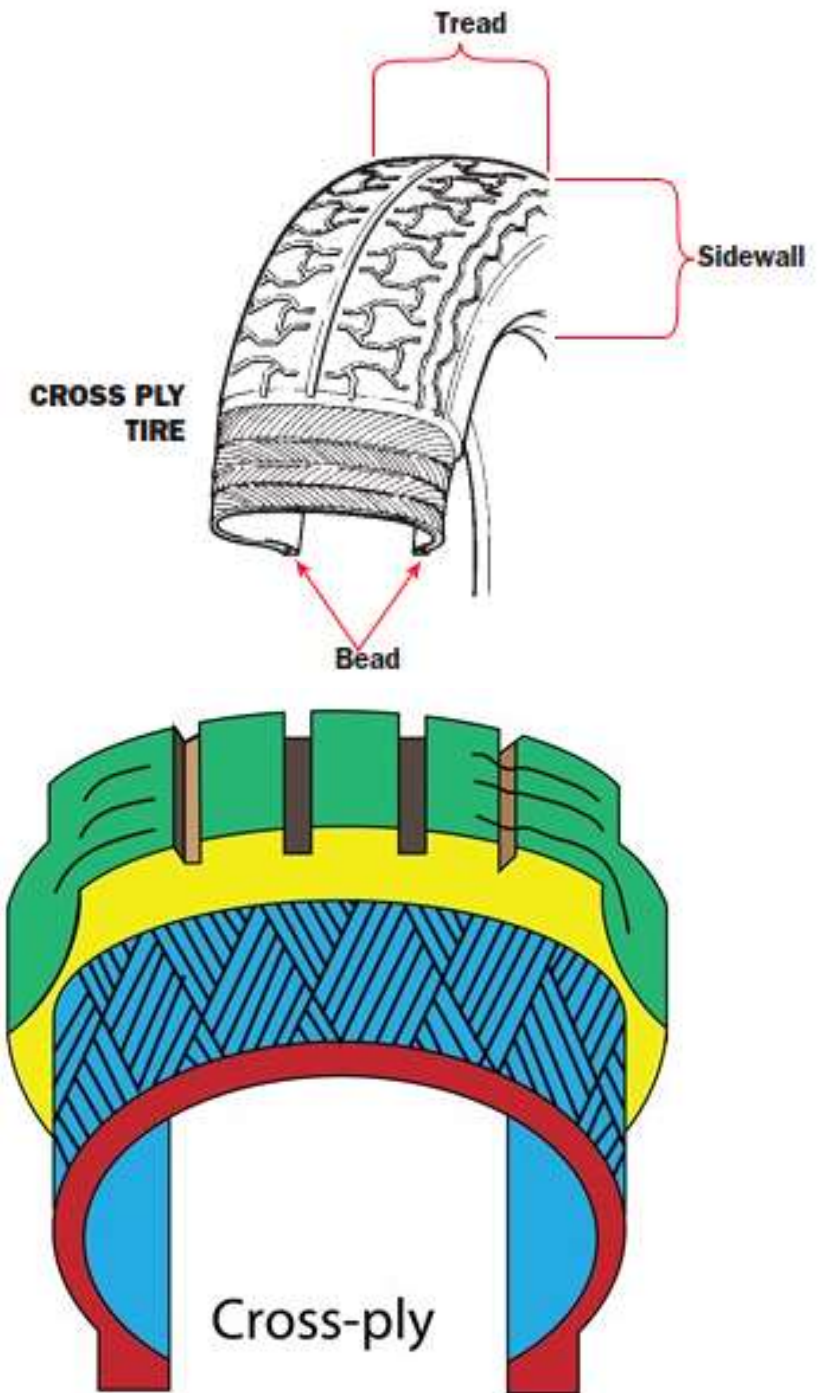
Parts of the tire

Radial and diagonal (Cross) ply

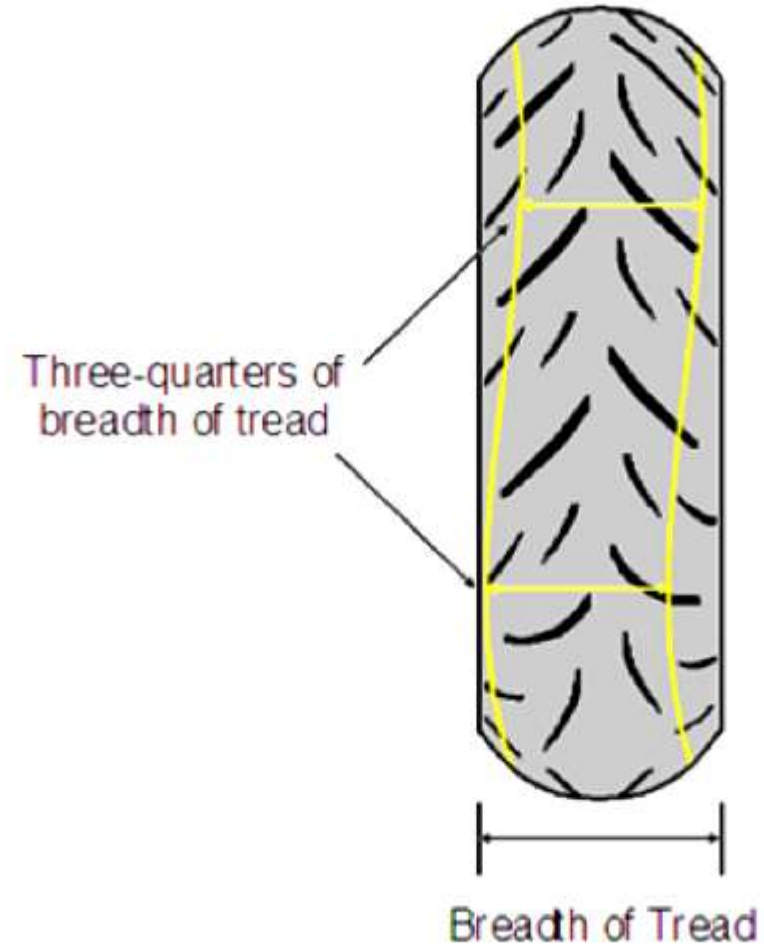
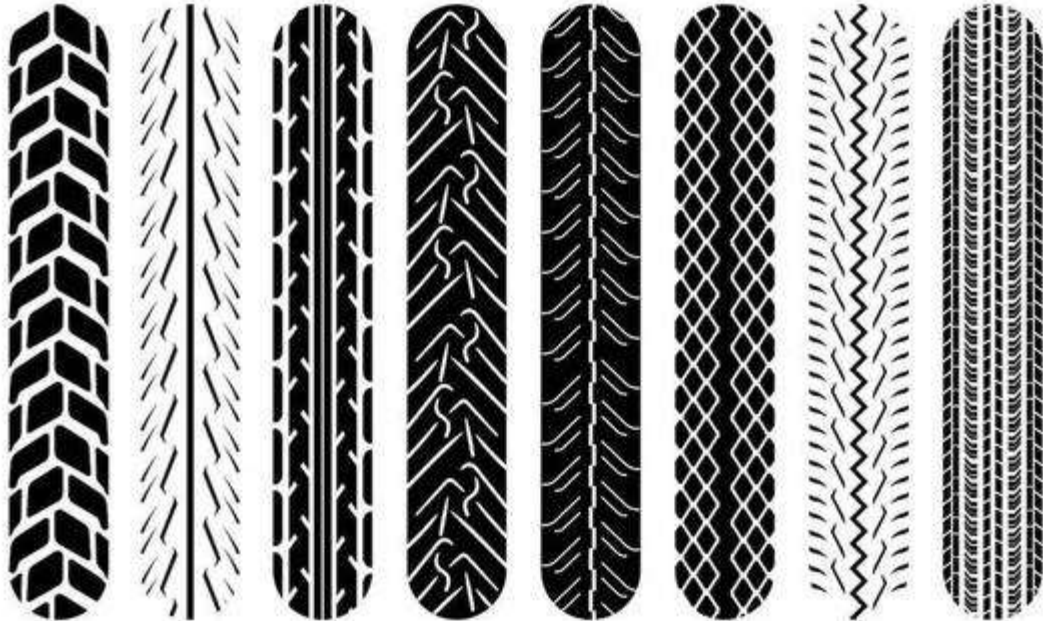
- The **radial tyre** was a development of the cross-ply design that was able to hold pressurized air within itself through new and more robust methods of construction. By running steel cords at a far wider angle of 90 degrees, and with the addition of steel belts to support the tread area of a tyre, the radial design was able to do away with inner tubes, simplifying production and giving additional benefits of improved ride and handling.



- **Diagonal (Cross) ply** The name cross-ply refers to the way in which the tyre is constructed using a network of interlocking cords which are layered across each other at a 45 degree angle, before being encased in the toughened rubber outer shell. This web of overlapping cords is rigid and highly inflexible, which gives the tyre sidewall a huge amount of strength to withstand impacts. This strength is key, as cross ply construction is reliant on an inflated inner tube to support the tyre on the rim.

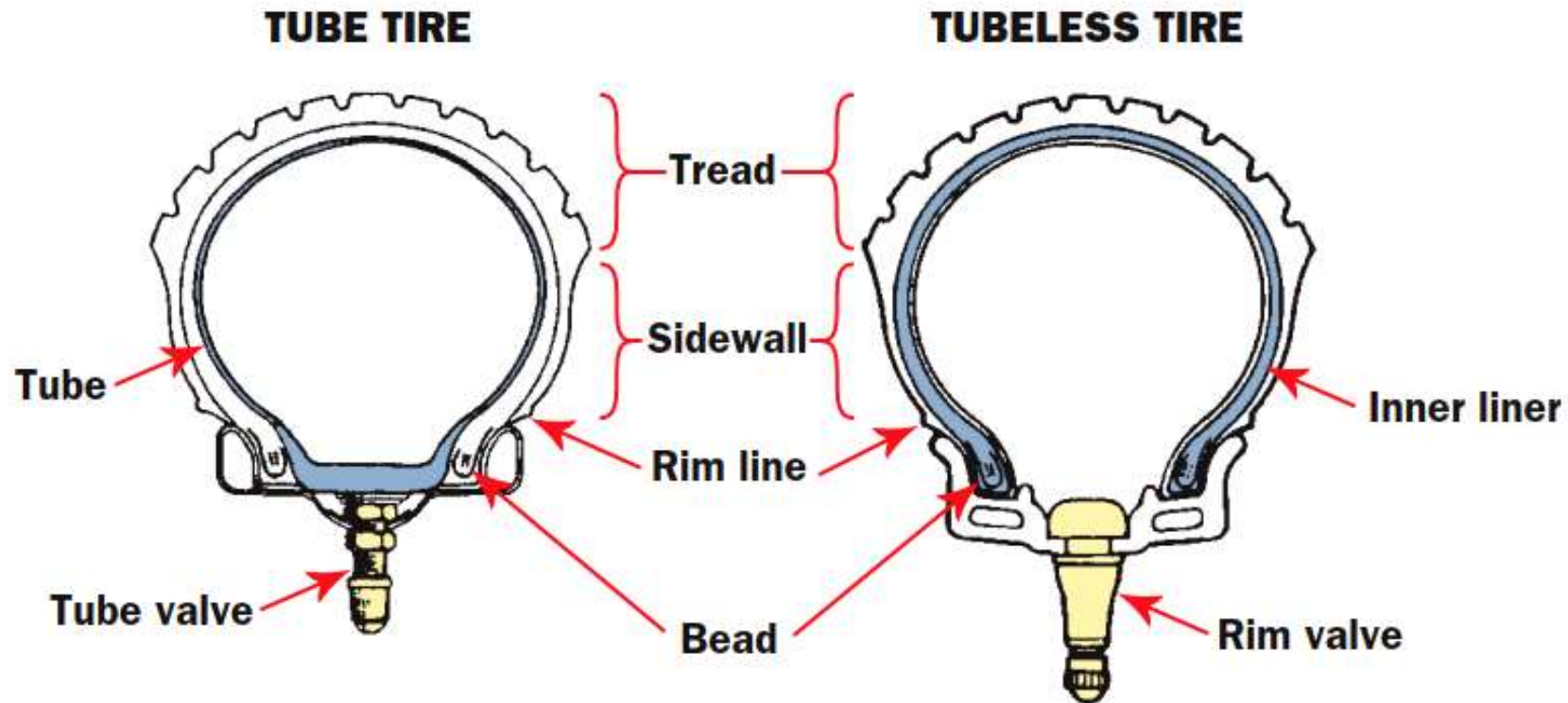


- **Tire treads** refers to the ribbed pattern on a tire. These patterns work to move water, mud and snow out of your tires so you can stop quickly and safely



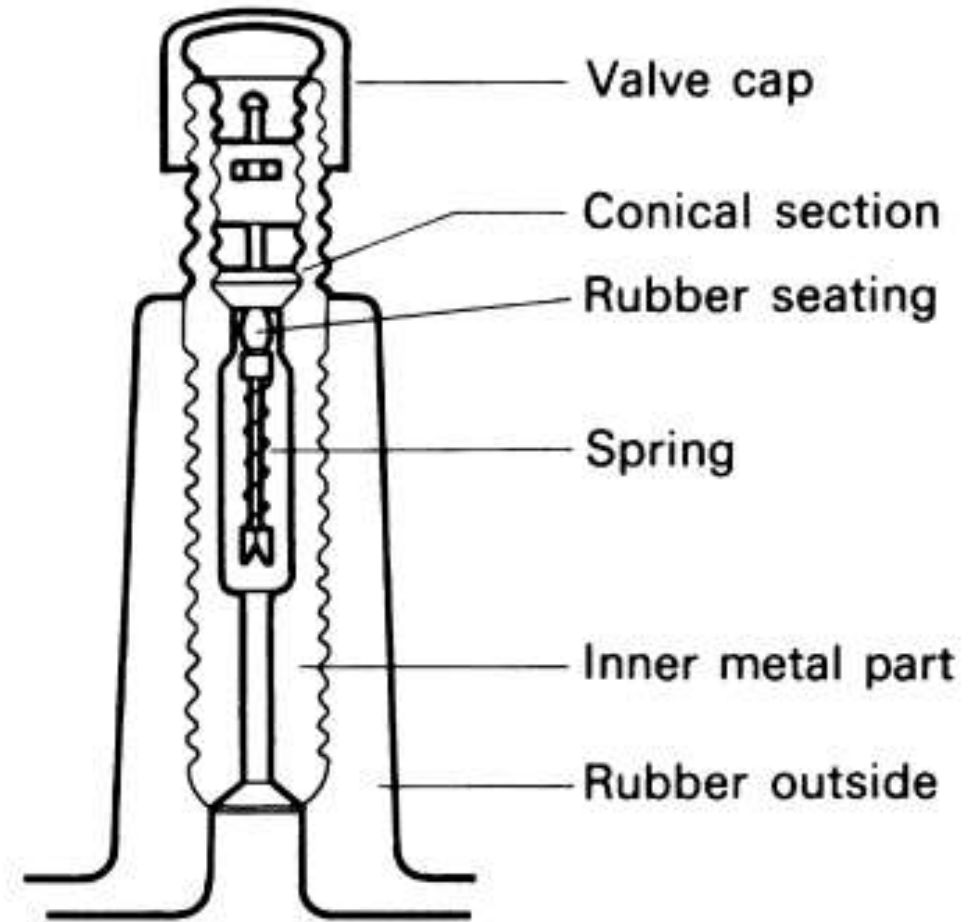
Inner Tubes

- Tubed tires use an air-filled tube within the tire's casing. Air pressure drops instantly when a nail or other sharp object penetrates the tire and tube.
- Tubeless tires have an inner liner bonded to the inside of the tire instead of a tube. The liner has a special bead area that provides an effective seal against pressure loss. Since the thick liner is not separate from the tire, it does not stretch when inflated and will not burst if punctured. Instead, the liner closes around the puncturing object to prevent substantial pressure loss.



Tire valves

- The **Schrader valve** is a type of pneumatic tire valve used on virtually every motor vehicle in the world today. The Schrader valve consists of a valve stem into which a valve core is threaded. The valve core is a poppet valve assisted by a spring. A small rubber seal located on the core keeps the fluid from escaping through the threads



Schrader valve

BASICS OF ELECTRICITY

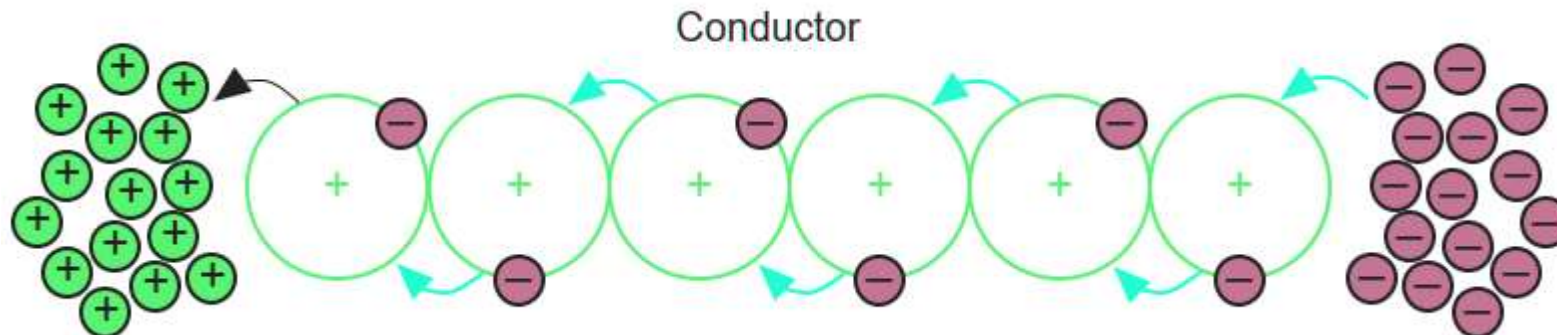
- Electricity is the flow of electrons from one place to another. Electrons can flow through any material, but does so more easily in some than in others. How easily it flows is called resistance. The resistance of a material is measured in Ohms.
- Matter can be broken down into:**Conductors:** electrons flow easily. Low resistance.**Semi-conductors:** electron can be made to flow under certain circumstances. Variable resistance according to formulation and circuit conditions.
- **Insulator:** electrons flow with great difficulty. High resistance. Since electrons are very small, as a practical matter they are usually measured in very large numbers. A Coulomb is 6.24×10^{18} electrons.
- The flow of electrons is called **current**, and is measured in AMPS. **One amp is equal to a flow of one coulomb per second** through a wire. Making electrons flow through a resistance requires an attractive force to pull them. This force, called Electro-Motive Force or EMF, is measured in **volts**.
- A Volt is the force required to push 1 Amp through 1 Ohm of resistance. As electrons flow through a resistance, it performs a certain amount of work. It may be in the form of heat or a magnetic field or motion, but it does something. This work is called Power, and is measured in Watts. One Watt is equal to the work performed by 1 Amp pushed by 1 Volt through a resistance.

AMPS is amount of electricity.

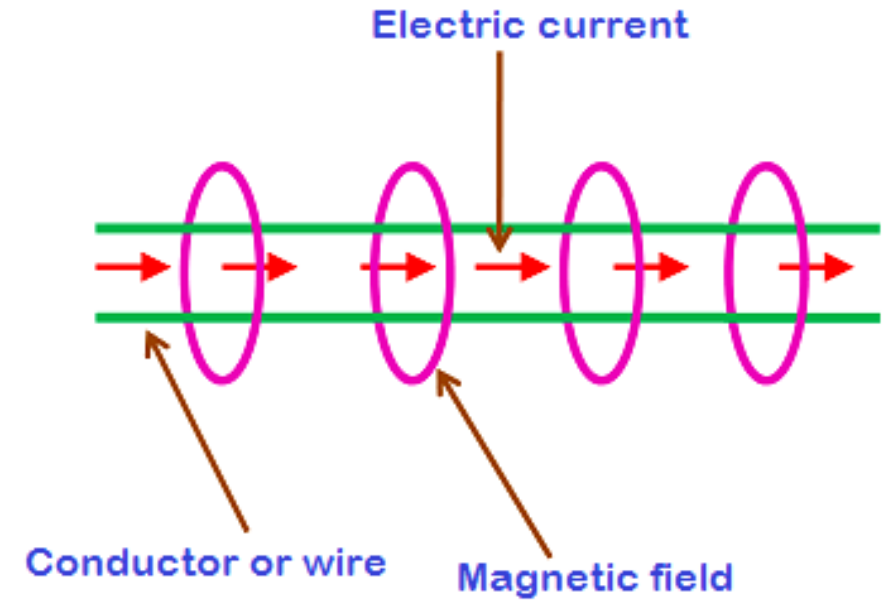
VOLTS is the Push, not the amount.

OHMS slows the flow.

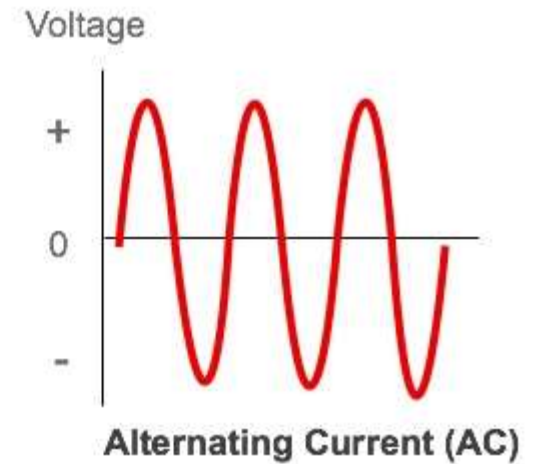
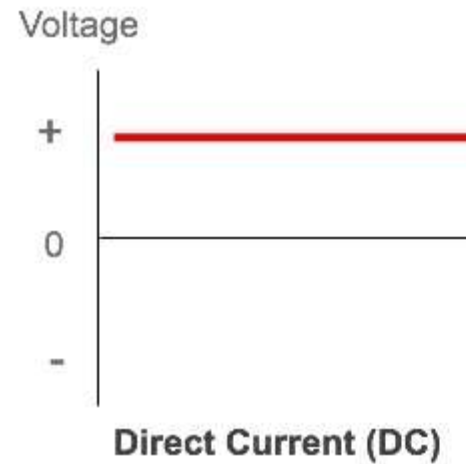
WATTS is how much gets done.



- **Electricity and magnetism** are two related phenomena produced by the electromagnetic force. Together, they form electromagnetism. A moving electric charge generates a magnetic field. A magnetic field induces electric charge movement, producing an electric current.



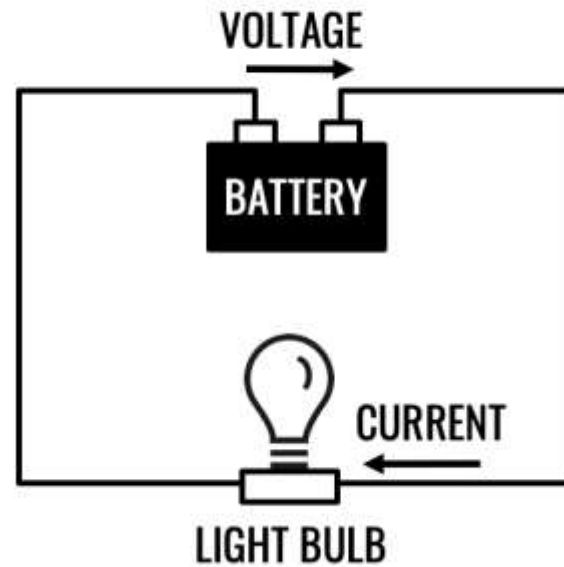
- Both **AC** and **DC** describe types of current flow in a circuit. In direct current (DC), the electric charge (current) only flows in one direction. Electric charge in alternating current (AC), on the other hand, changes direction periodically.



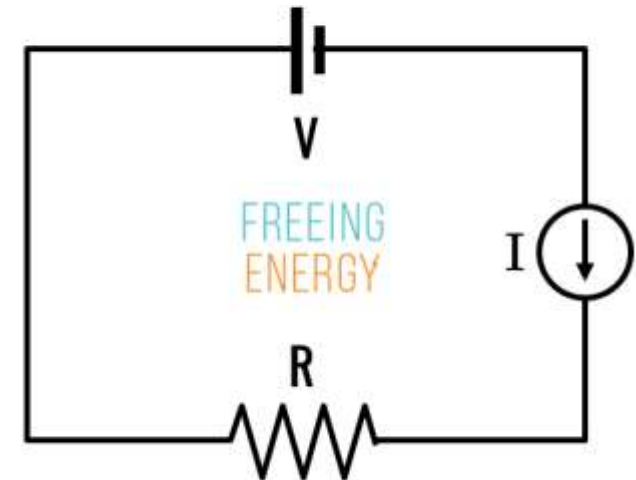


$$\text{Voltage} = \text{Current} \times \text{Resistance}$$
$$(V = I \times R)$$

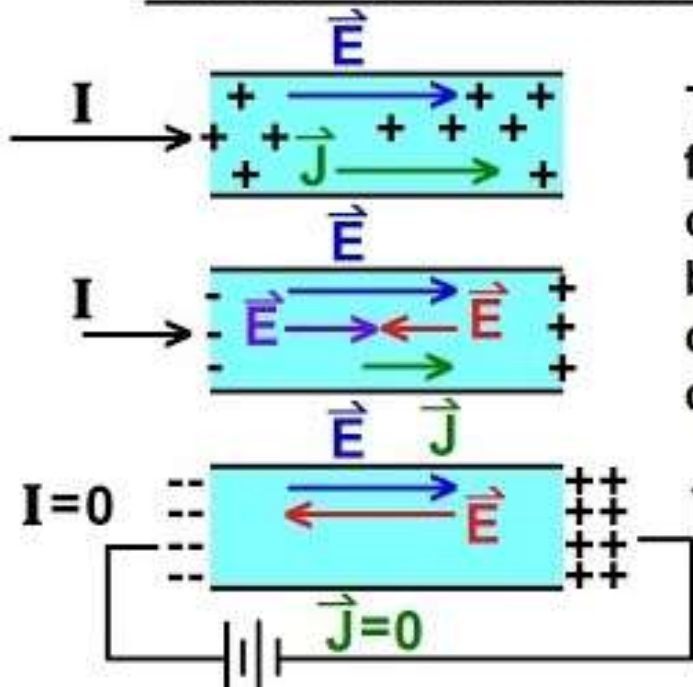
Electricity



Circuit Diagram

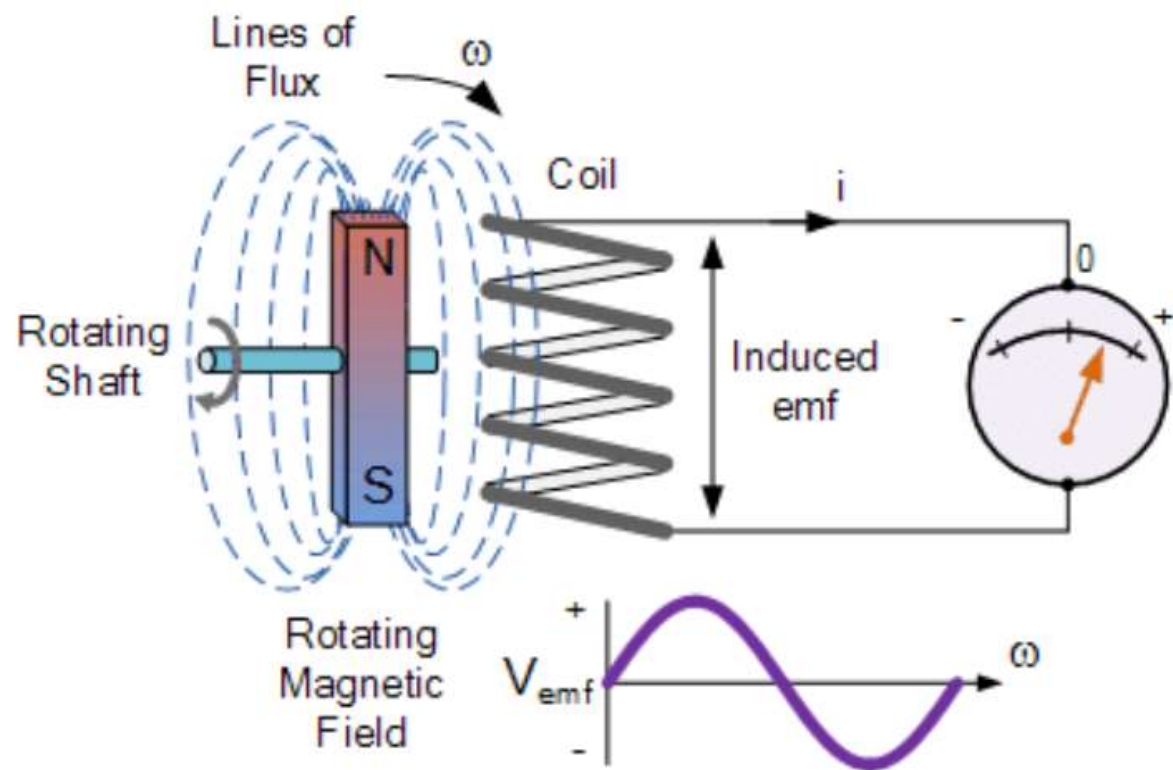


What is the Electromotive Force?

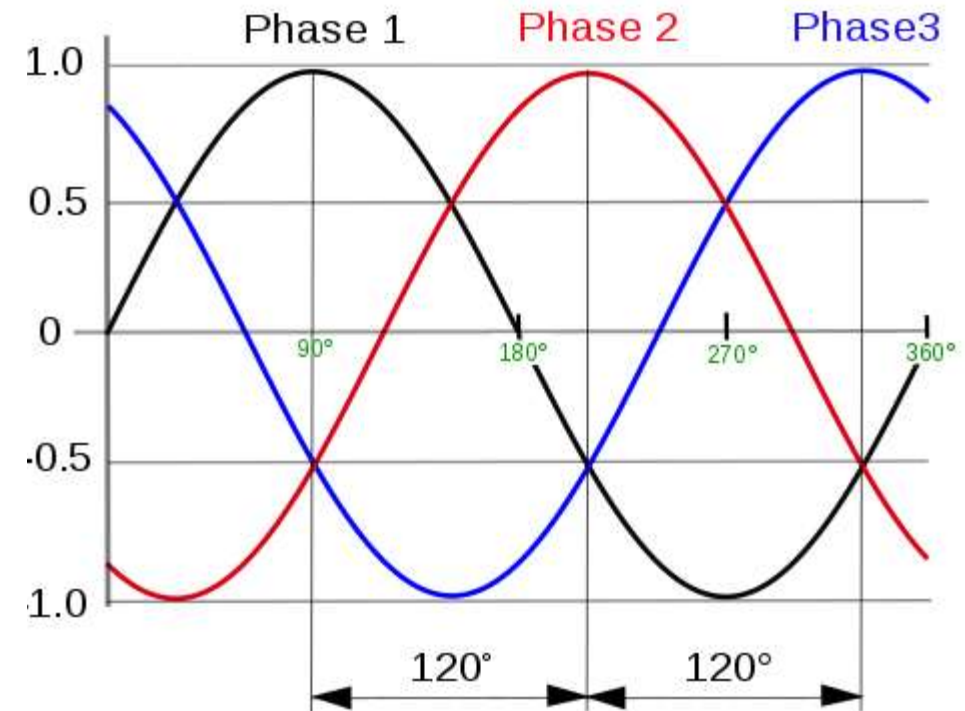
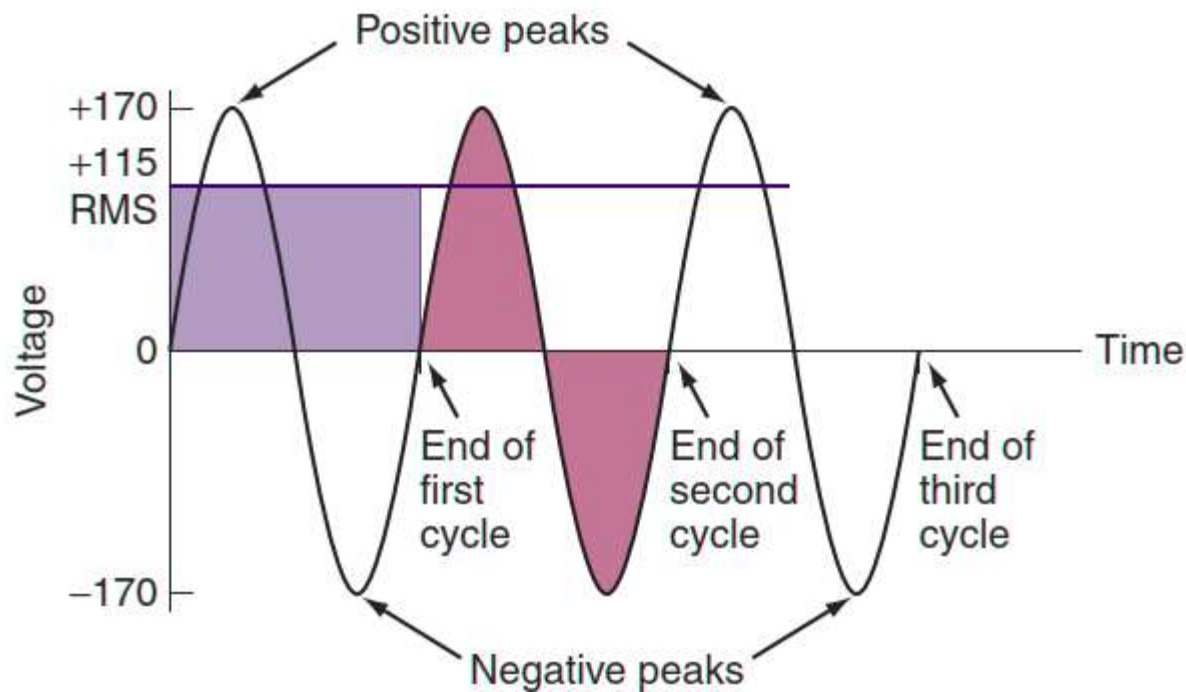
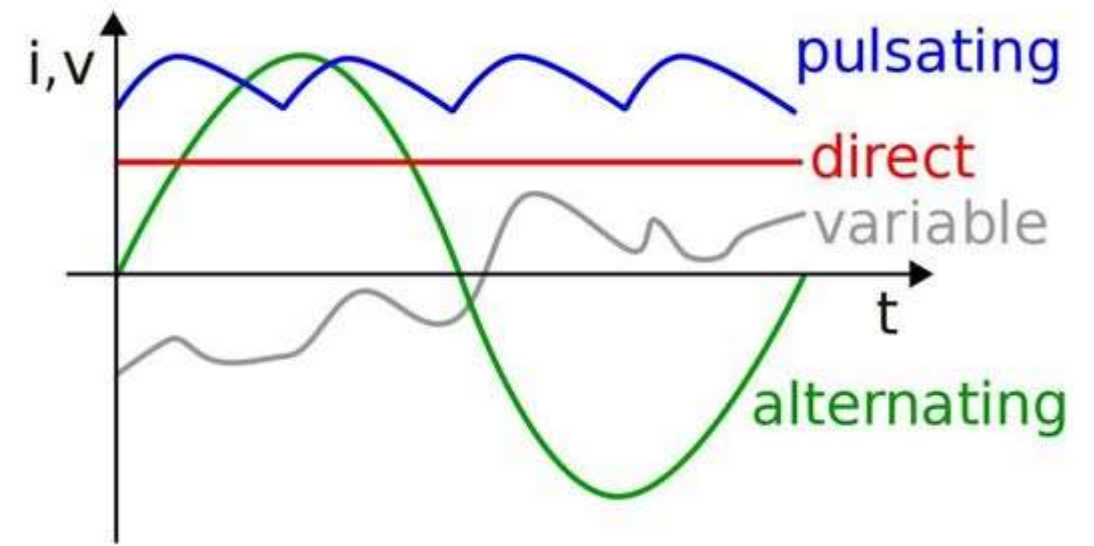


To keep the current flowing through the conductor there must be a force pushing the charges through the conductor.

The electromotive force (EMF)



- The action and measurement of alternating current.
- the sine waves of three Phase




Circuit Terminology

A ——— B Closed

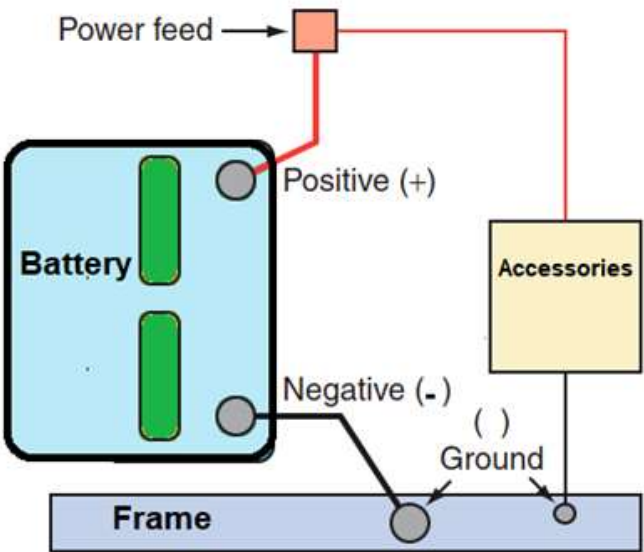
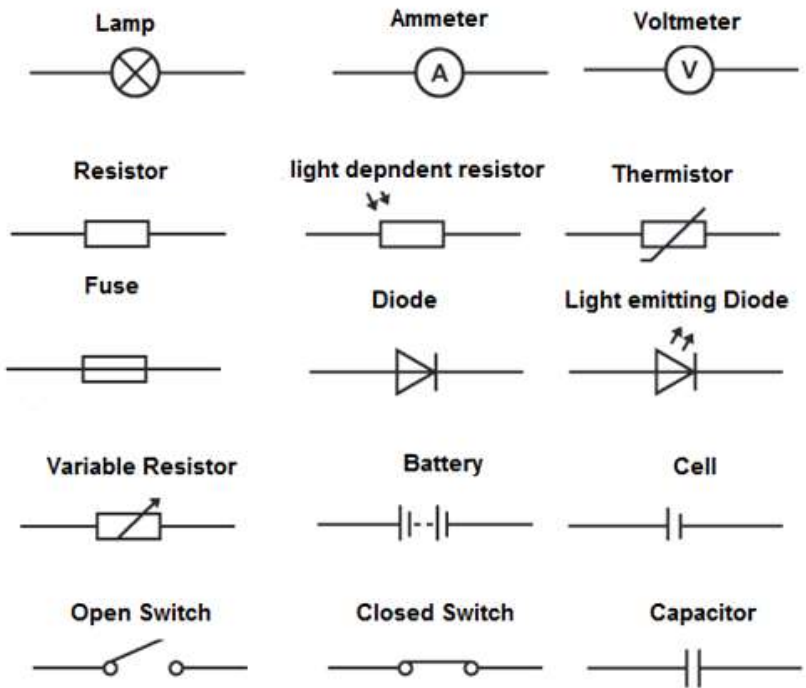
A — — B Open

Conductors are drawn as lines from one point to another.

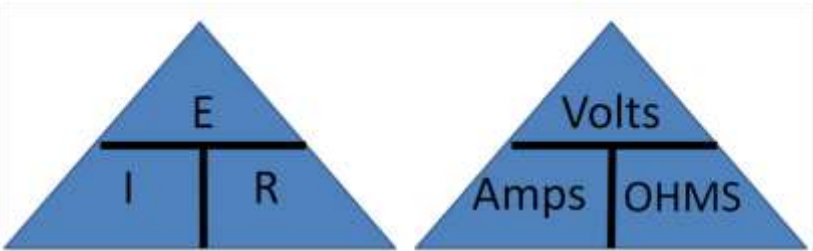

Symbol for a resistor.

 (A)  (B)

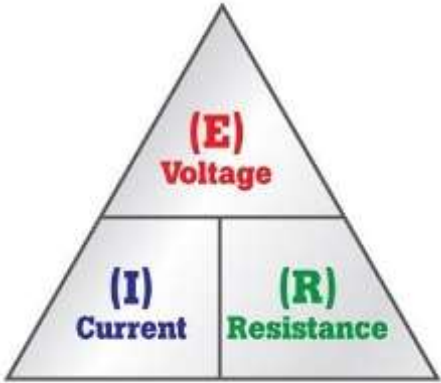
Symbols for grounds: (A) made through the component's mounting (B) made by a remote wire.



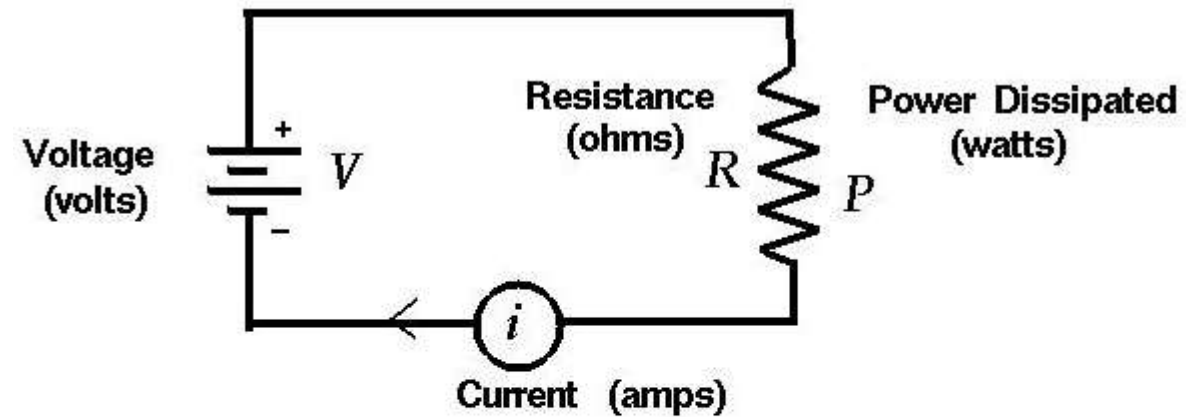
Most automotive electrical circuits use the chassis as the conductor for the negative side of the battery.



Volts ÷ Amps = Ohms
Volts ÷ Ohms = Amps
Ohms X Amps = Volts



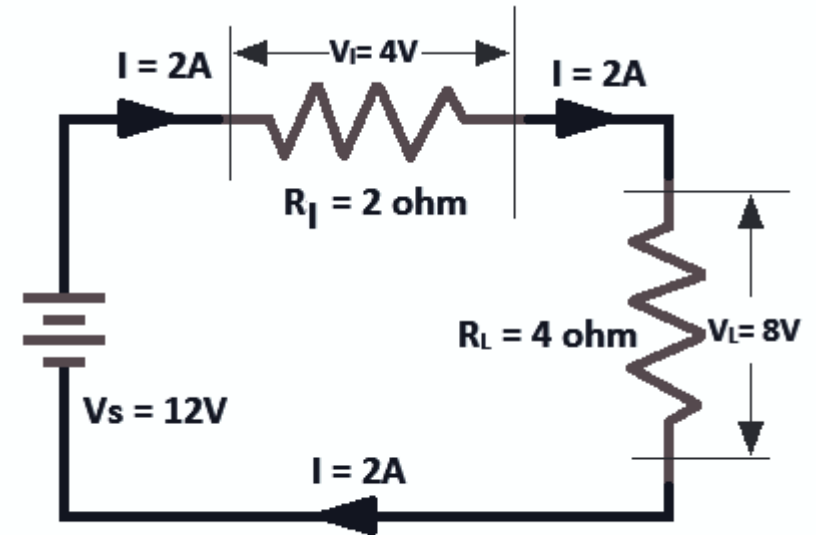
- **Ohm's law** states the relationship between electric current and potential difference. The current that flows through most conductors is directly proportional to the voltage applied to it



$$V = i R$$

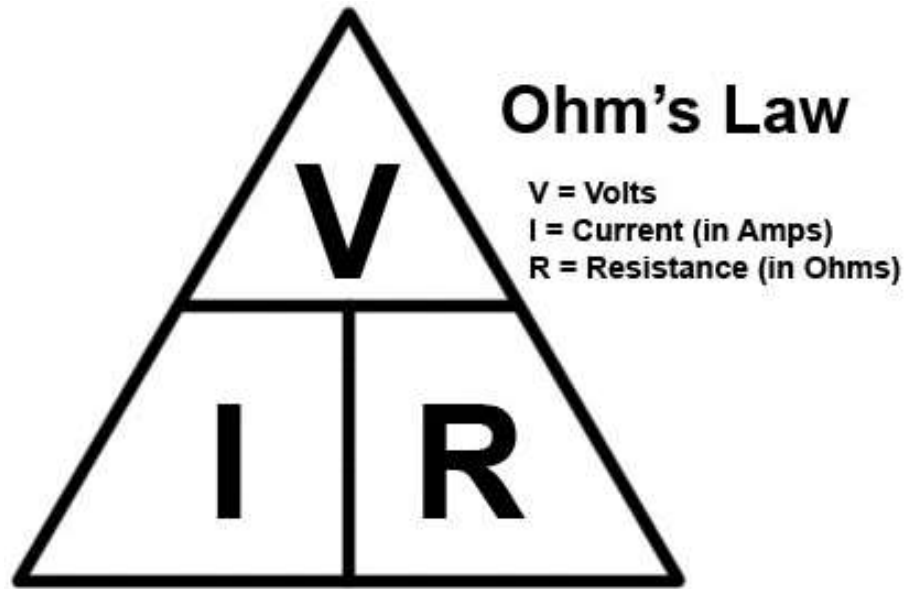
$$P = i V = i^2 R$$

Voltage drop is the decrease of electrical potential along the path of a current flowing in an electrical circuit. Voltage drops in the internal resistance of the source, across conductors, across contacts, and across connectors are undesirable because some of the energy supplied is dissipated.



Voltage Drop Explanation

Power and Watt's Law




$$V = I \cdot R$$

$$V = I \cdot R$$

(volts = amps times ohms)


$$I = \frac{V}{R}$$

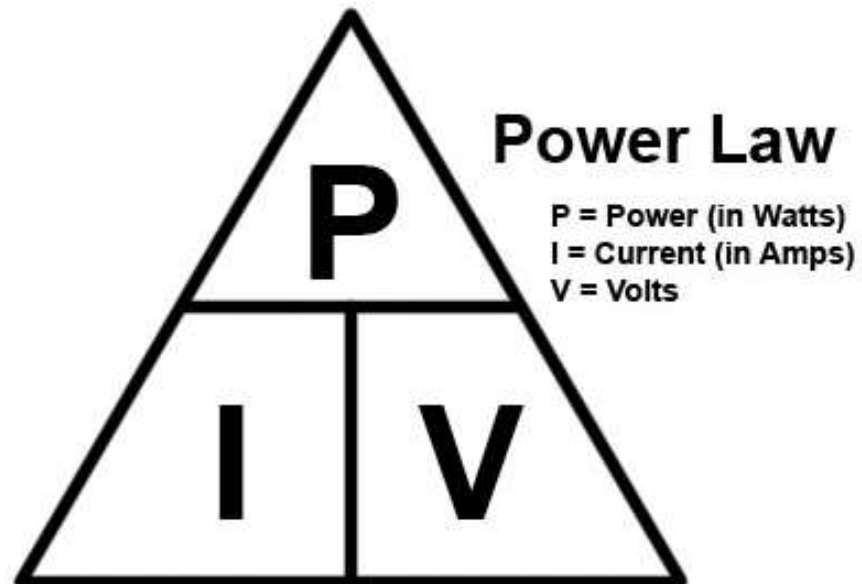
$$I = \frac{V}{R}$$

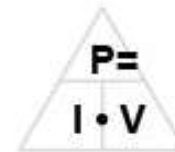
(amps = volts divided by ohms)


$$R = \frac{V}{I}$$

$$R = \frac{V}{I}$$

(ohms = volts divided by amps)




$$P = I \cdot V$$

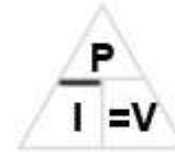
$$P = I \cdot V$$

(watts = amps times volts)


$$I = \frac{P}{V}$$

$$I = \frac{P}{V}$$

(amps = watts divided by volts)


$$V = \frac{P}{I}$$









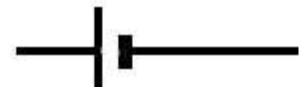
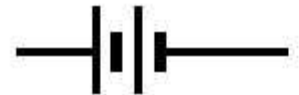
$$V = \frac{P}{I}$$

(volts = watts divided by amps)

CIRCUITS

- An electric circuit is a closed loop network which provides a return path for the flow of current. Or a closed conducting path in which current can flow is called a circuit. An electric circuit is also known as electrical network or electrical circuit.

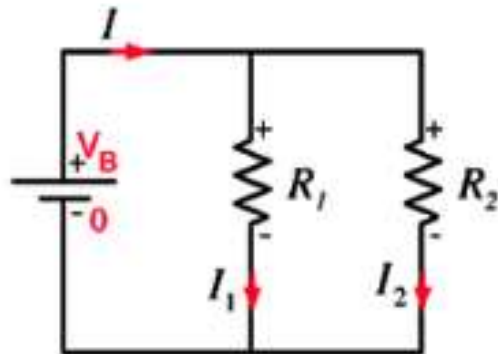
Circuit Symbols

wire		ammeter	
open switch		voltmeter	
closed switch		fuse	
resistor		light bulb	
single cell			
battery			



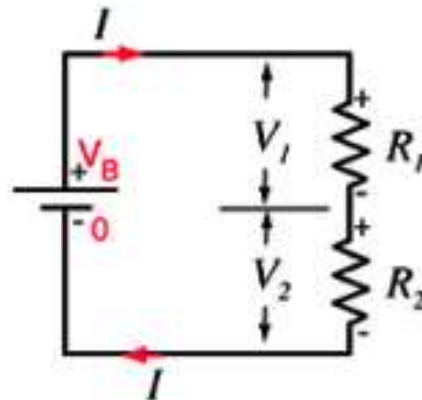
- **Series Circuit** In this circuits, all the electrical elements (Voltage or Current sources, inductors, capacitors, resistors etc) are connected in series. There is only one path for traveling electricity. these are single branch circuits.
- **Parallel Circuit** In this circuits, all the electrical elements (Voltage and Current sources, inductors, capacitors, resistors etc) are connected in parallel. There are many paths for traveling electricity and the minimum branches in this circuit are two.

Series And Parallel DC Circuits



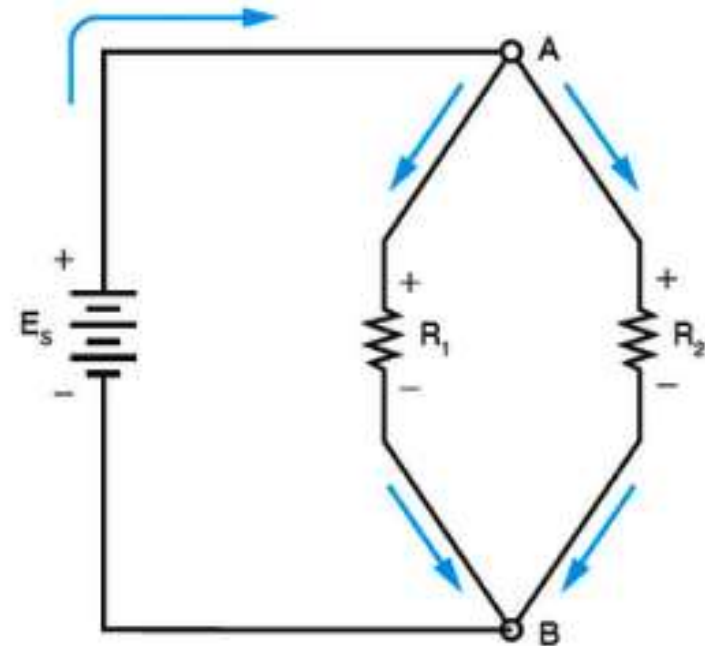
Parallel resistors

$$\frac{1}{R_{equivalent}} = \frac{1}{R_1} + \frac{1}{R_2}$$

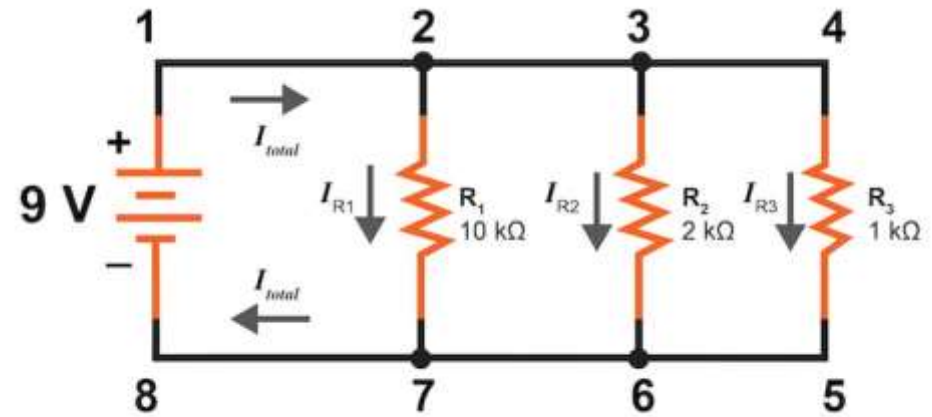


Series resistors

$$R_{equivalent} = R_1 + R_2$$



Parallel Circuit



total current $I_{total} = I_{R1} + I_{R2} + I_{R3} = 0.9 + 4.5 + 9.0 = 14.4 \text{ mA}$

$$R_{total} = \frac{V_{total}}{I_{total}} = \frac{9 \text{ V}}{14.4 \text{ mA}} = 625 \Omega$$

$$R_{total} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

$$I_{R1} = \frac{V_{R1}}{R_1} = \frac{9 \text{ V}}{10 \text{ k}\Omega} = 0.9 \text{ mA}$$

$$I_{R2} = \frac{V_{R2}}{R_2} = \frac{9 \text{ V}}{2 \text{ k}\Omega} = 4.5 \text{ mA}$$

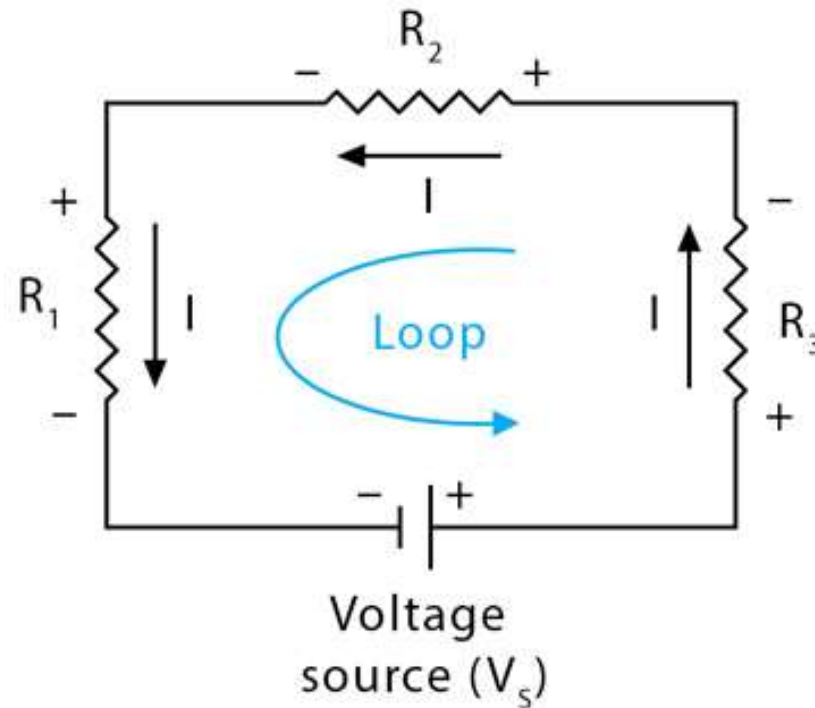
$$I_{R3} = \frac{V_{R3}}{R_3} = \frac{9 \text{ V}}{1 \text{ k}\Omega} = 9.0 \text{ mA}$$

Kirchhoff's Law

- The total current entering a junction or a node is equal to the charge leaving the node as no charge is lost.
- The voltage around a loop equals the sum of every voltage drop in the same loop for any closed network and equals zero.

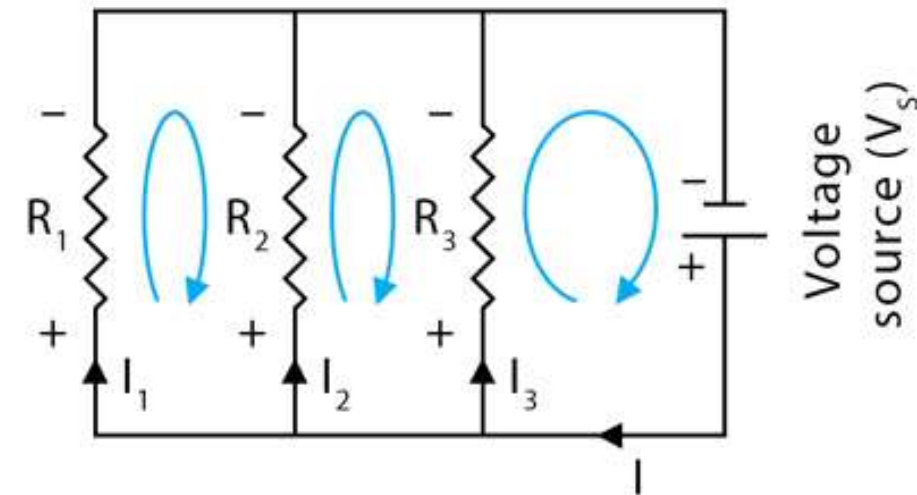
Kirchhoff's Law Circuit Diagram

Resistances in series



$$IR_1 + IR_2 + IR_3 - V_s = 0$$

Resistances in parallel



$$I = I_1 + I_2 + I_3$$

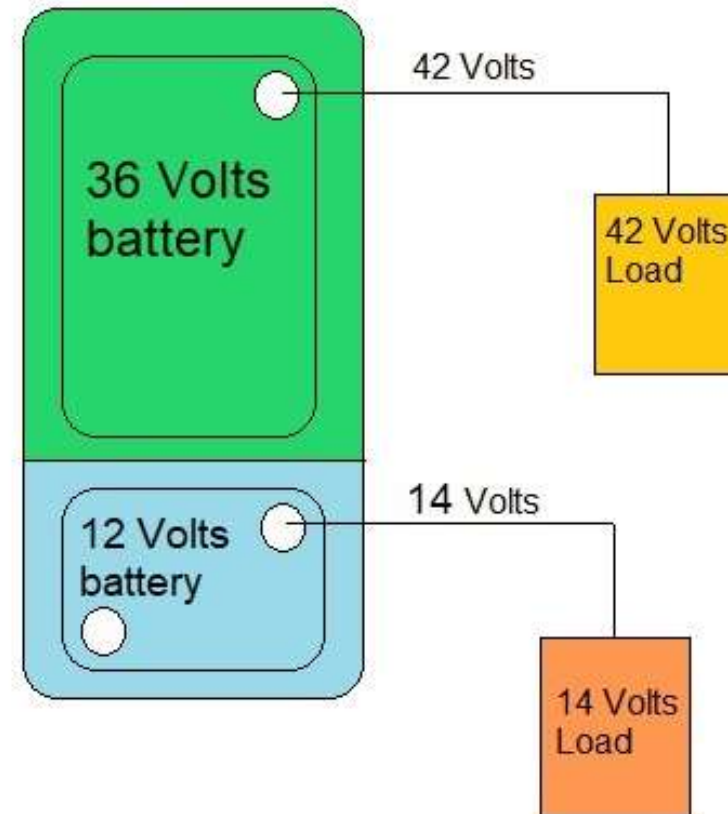
$$I_1 R_1 = I_2 R_2 = I_3 R_3 = V_s$$

CIRCUIT COMPONENTS

Power Sources

- Most of today's vehicles operate with basically 12-volt electrical systems.
- Forty-two-volt systems are based on a single 36-volt battery but have dual voltage systems. Part of the vehicle is powered by 12 to 14 volts and the rest by 36 to 42 volts. The battery has two positive connectors, one for each voltage. The split voltage system provides 42 volts for high-voltage applications such as the starter/generator, power steering, air conditioning, brake, and engine cooling systems. The 14-volt system powers low-load systems, such as lights, power door locks, radios, and navigation systems.

Asplit Voltage arrangement provide 14 and 42 volts from 36 Volt battery



Resistors

- Resistors are used to limit current flow (and thereby voltage) in circuits where full current flow and voltage are not needed or desired. Automotive circuits typically contain these types of resistors: fixed value, stepped or tapped, and variable.
- Fixed value resistor's In electronic circuits, a fixed value resistor's primary function is to reduce current flow.
- A stepped or tapped resistor has two or more fixed taps that provide different resistance values. These taps allow current to flow through all or part of the resistor, which changes the amount of current flowing through the circuit.
- Variable resistors are designed to have a range of resistances available through two or more taps and a control. Two examples of this type of resistor are rheostats and potentiometers

Types of Resistors



Simple Resistor



Variable



Photoresistor



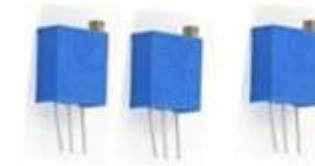
Adjustable



Tapped

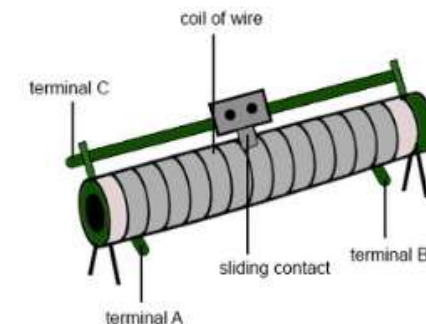
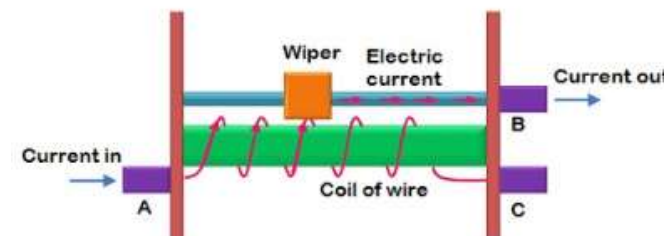


Thermistor

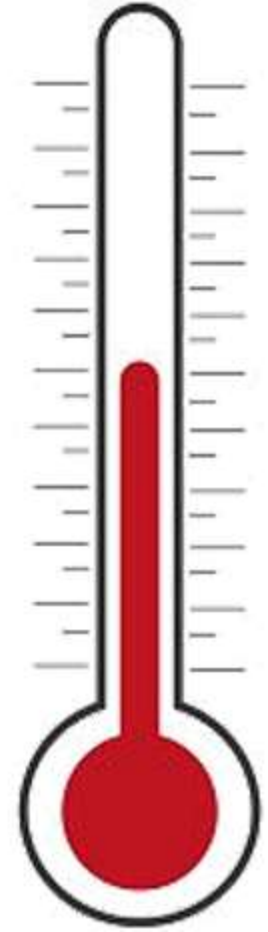
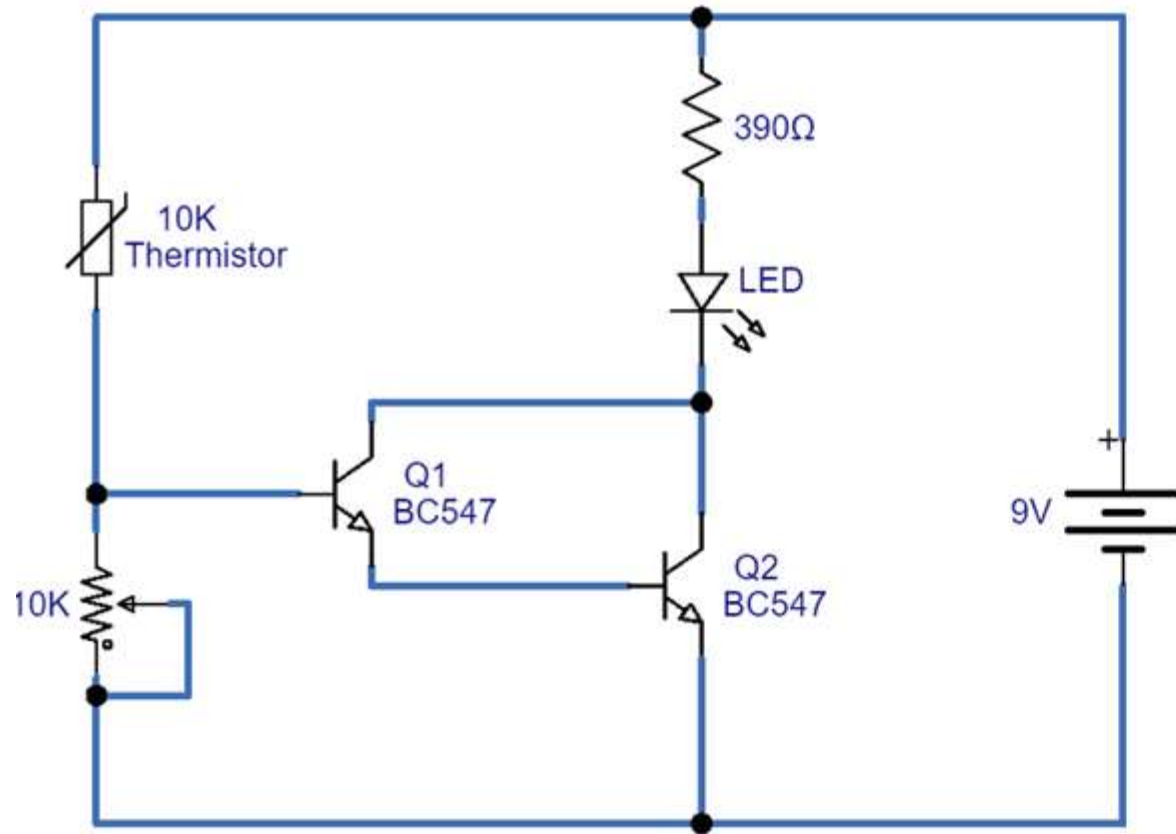


Trim Pot

Rheostats

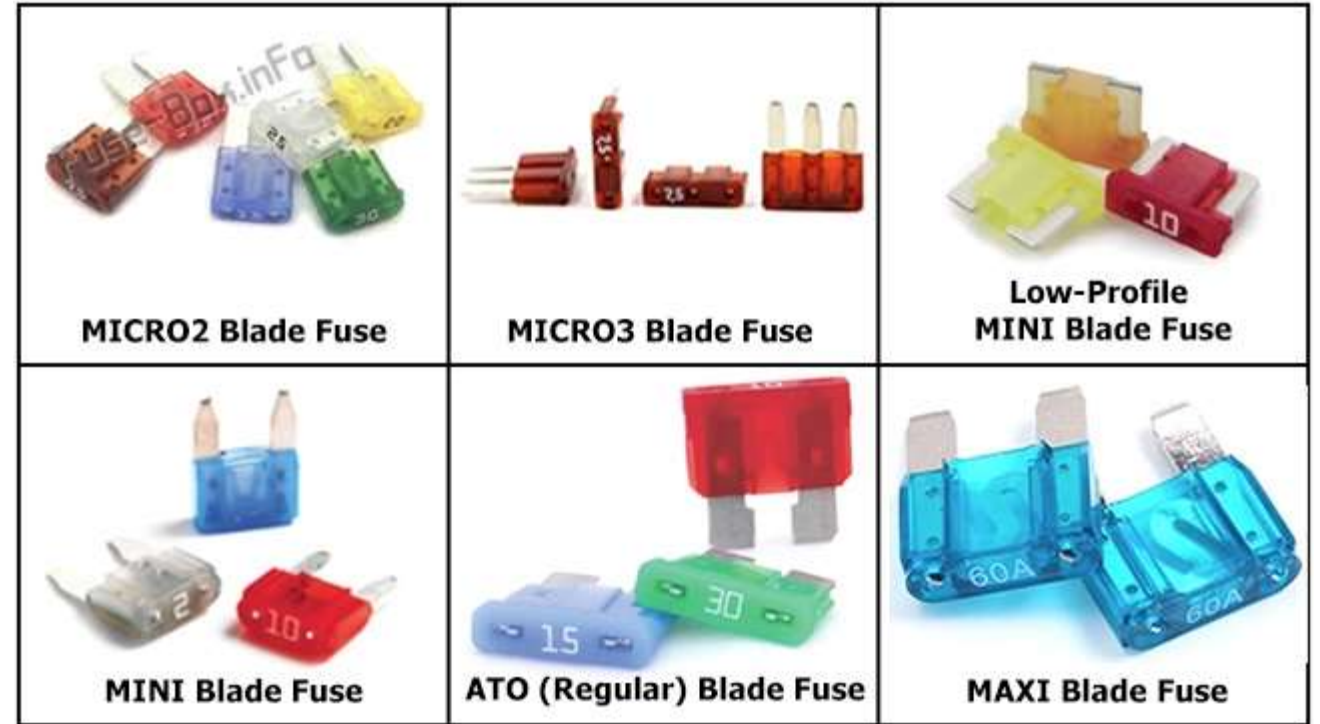


Thermistor This type of resistor is designed to change its resistance value as its temperature changes



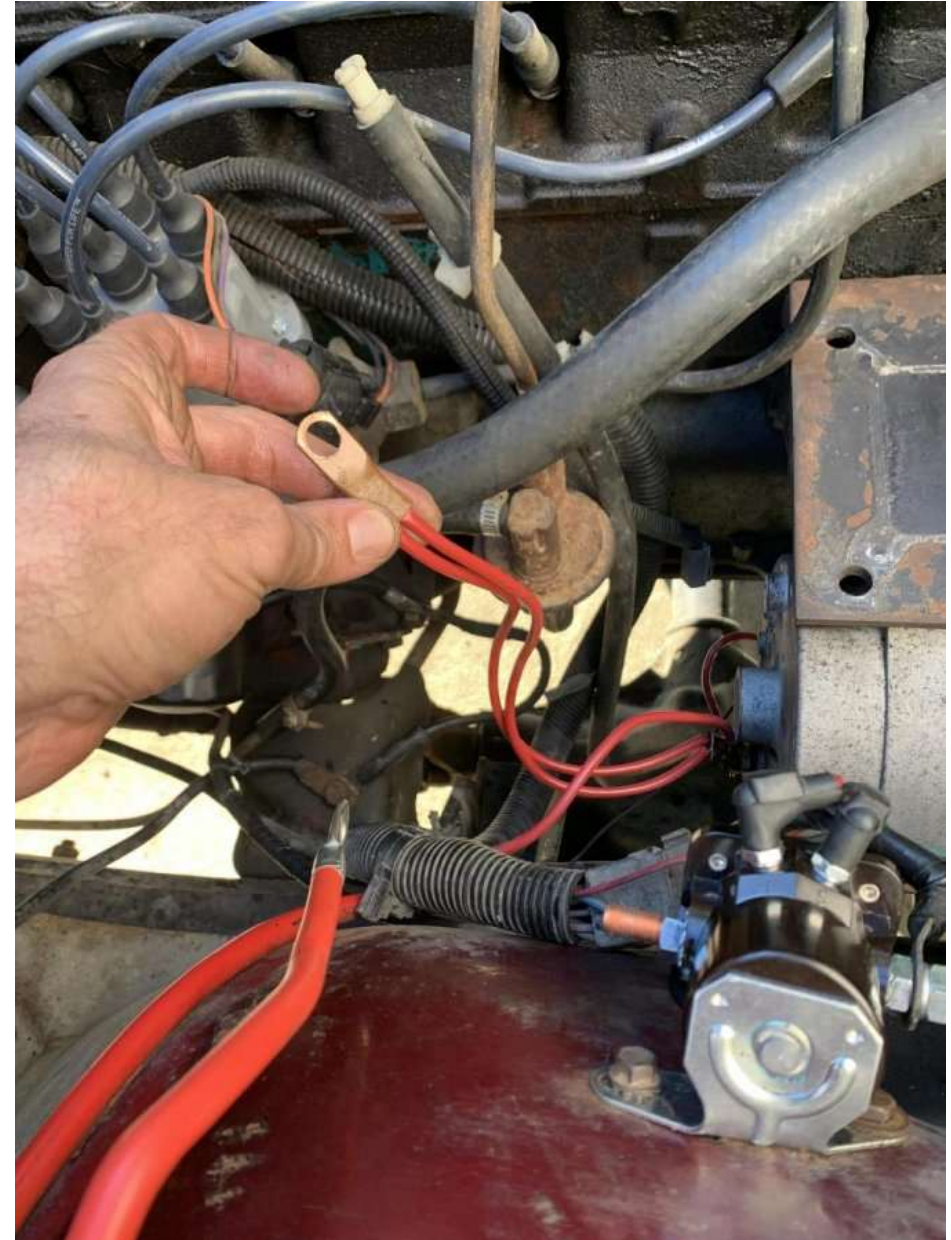
Circuit Protective Devices

- Fuse links, maxi-fuses, and circuit breakers are designed to provide protection from high current.
- Fuses There are three basic types of fuses in automotive use: cartridge, blade, and ceramic



Fuse Links

- Fuse or fusible links are used in circuits when limiting the maximum current is not extremely critical. They are often installed in the positive battery lead to the ignition switch and other circuits that have power with the key off



Maxi-Fuses

- Maxi Fusestyle automotive blade fuse is a time delay fuse, offered with 32, 58, and 80 volt DC ratings. The Maxi Fuse has ampere ratings ranging from 20 to 100 amps. It is used in a wide range of low voltage, automotive and electronic applications. A



Circuit Breakers Some circuits are protected by circuit breakers. They can be fuse panel mounted or inline. Like fuses, they are rated in amperes.



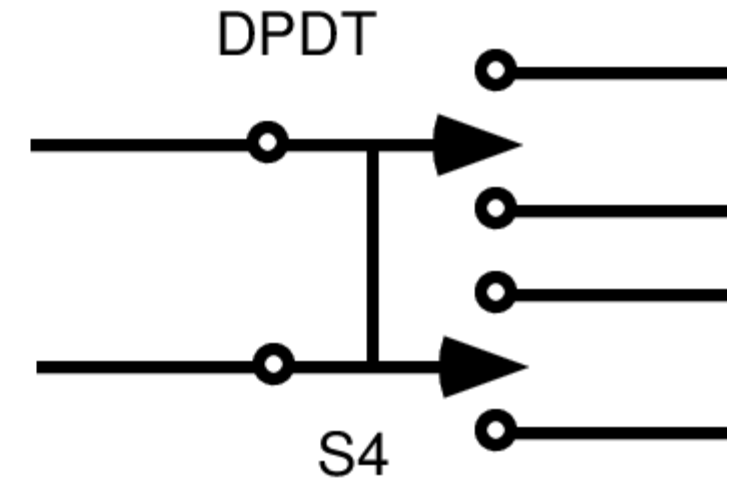
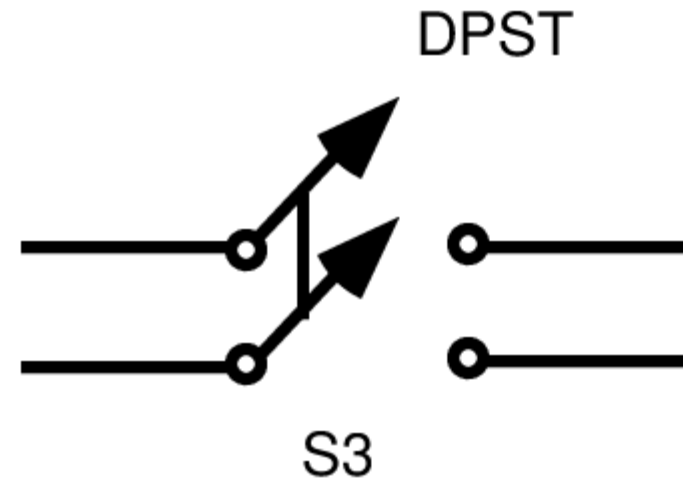
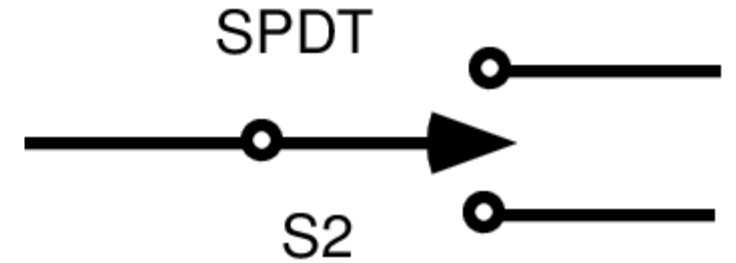
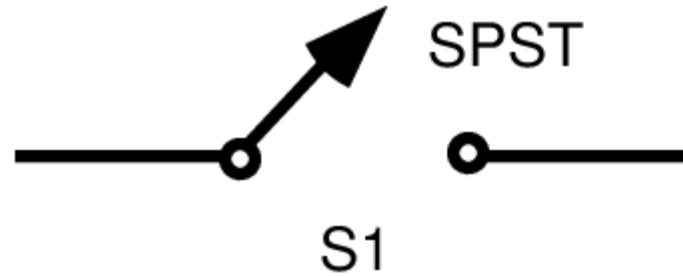
Circuit Breakers

Voltage Limiter Instrument panel gauges are protected against voltage fluctuations that could damage the gauges or give erroneous readings. A voltage limiter restricts voltage to the gauges to a particular amount.

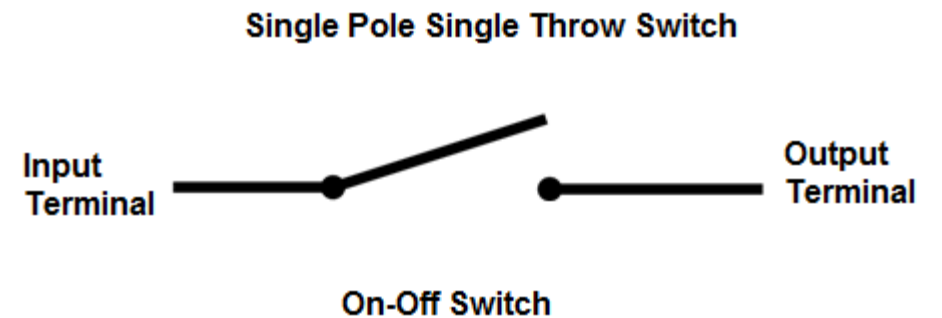


Switches

Switches do two things. They turn the circuit on or off, or they direct the flow of current in a circuit.



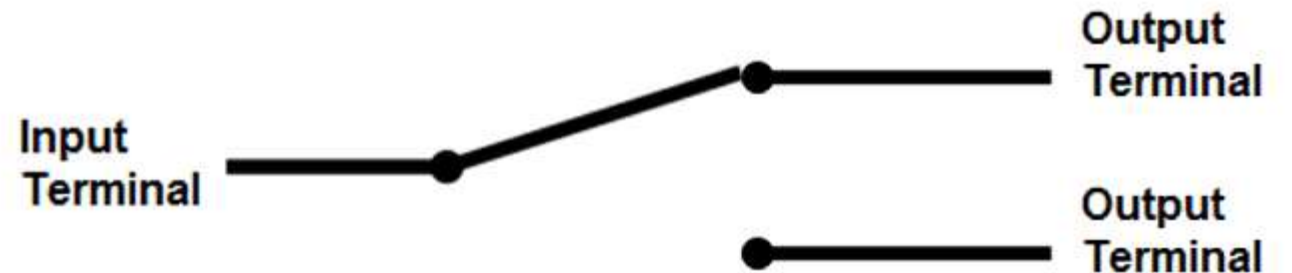
- A **Single Pole Single Throw (SPST)** switch is a switch that only has a single input and can connect only to one output. This means it only has one input terminal and only one output terminal.



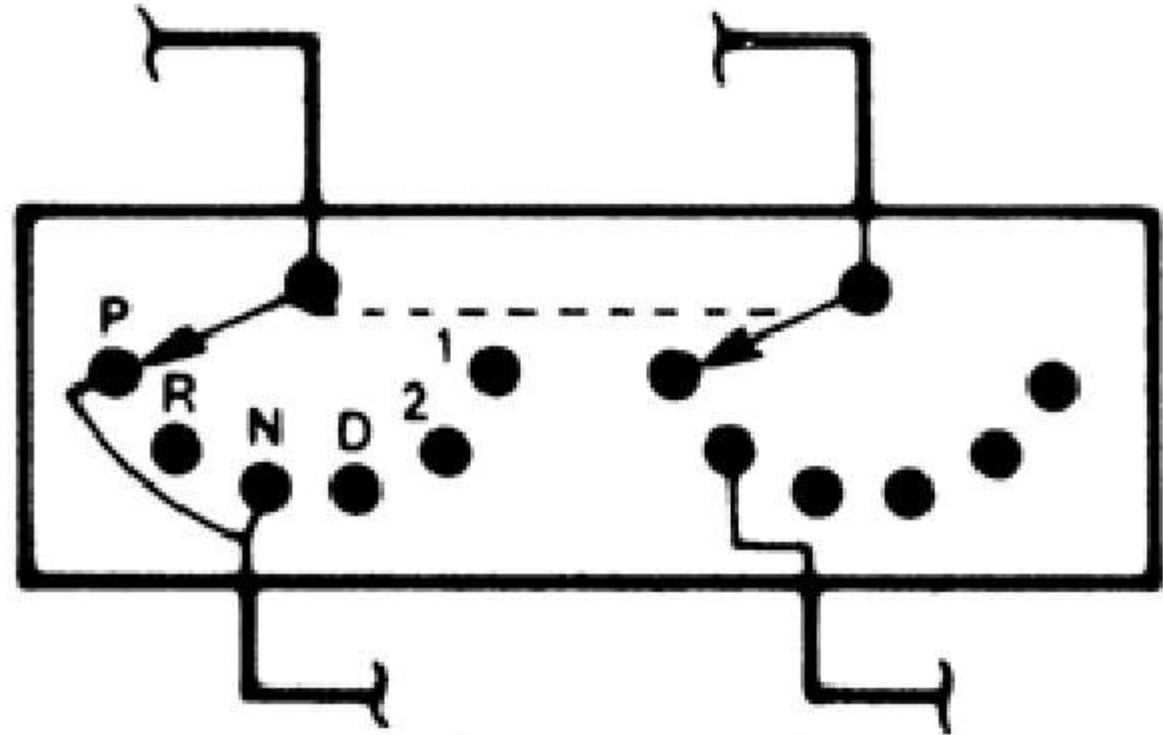
- A **Single Pole Double Throw (SPDT)** switch is a switch that only has a single input and can connect to and switch between the 2 outputs. This means it has one input terminal and two output terminals.

SPDT

Single Pole Double Throw Switch

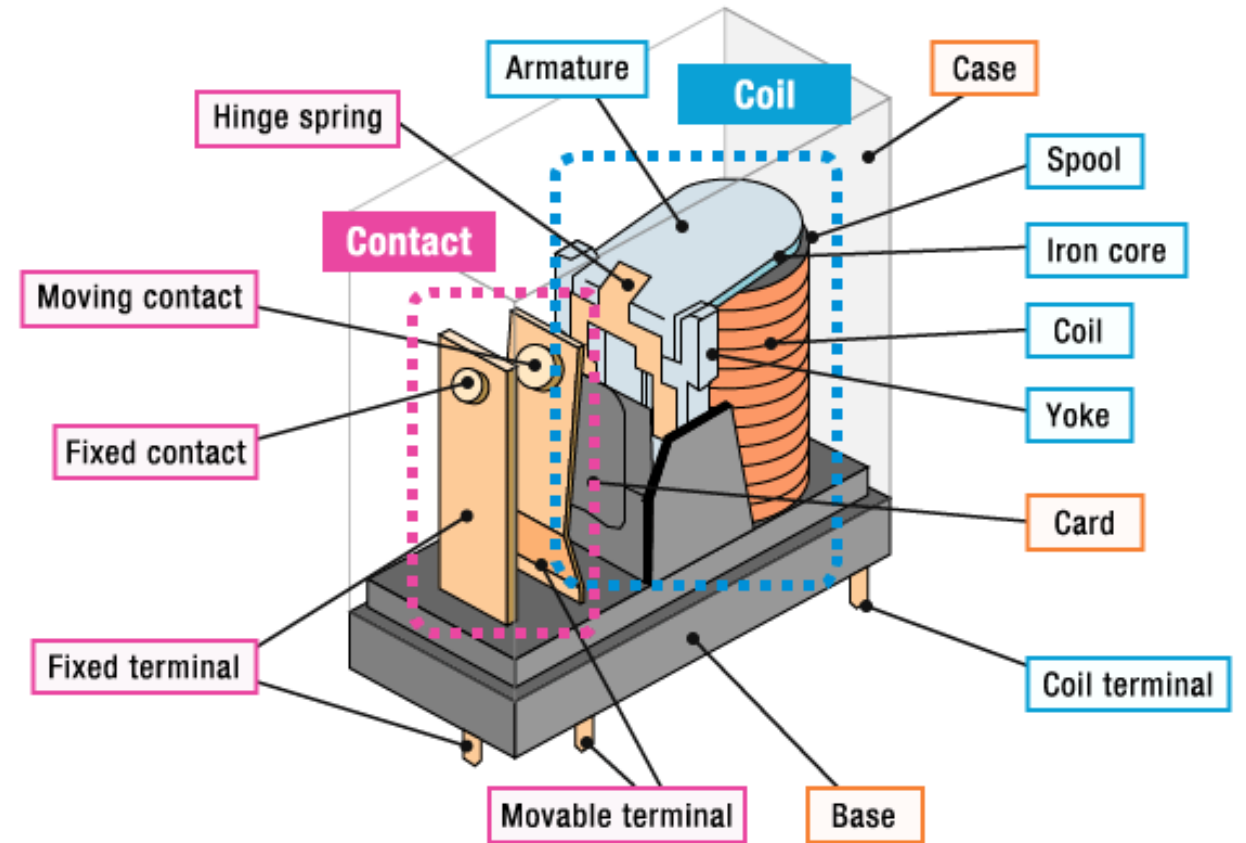


Multiple pole, multiple-throw (MPMT) has two poles and six throws

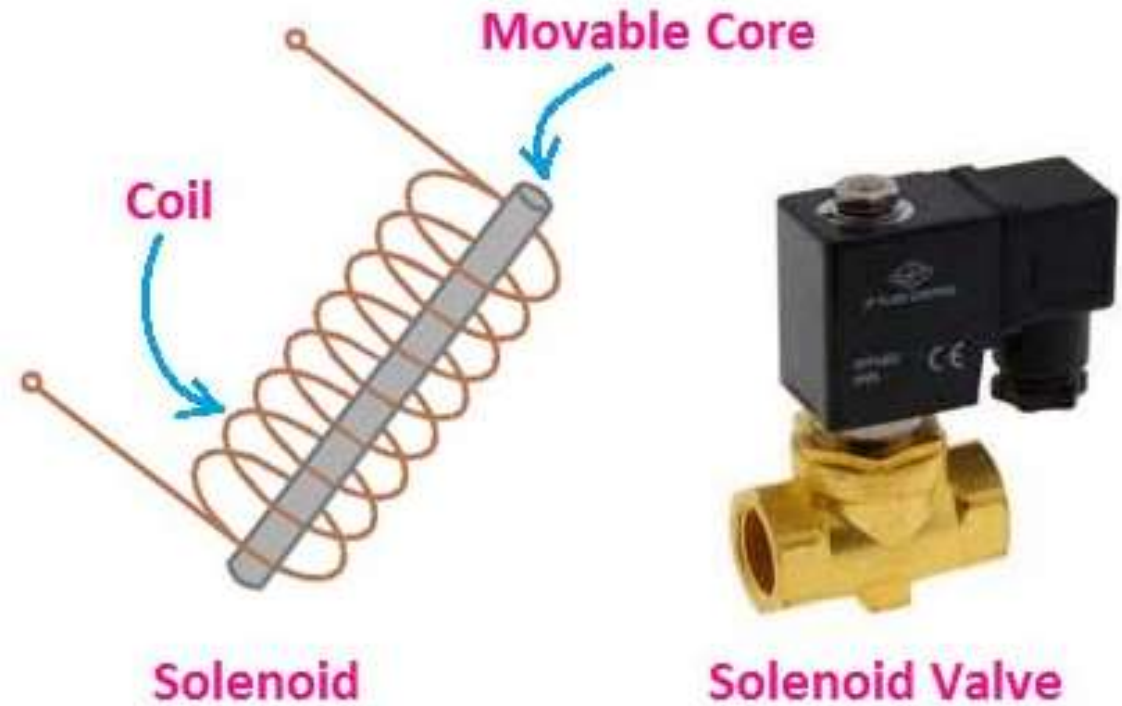


Multiple Pole Multiple Throw (MPMT)

Relays: A relay is an electric switch that allows a small amount of current to control a high-current circuit



A **solenoid** is a cylindrical coil of wire acting as a magnet when carrying an electric current. A solenoid is a device comprised of a coil of wire, the housing and a moveable plunger (armature). When an electrical current is introduced, a magnetic field forms around the coil which draws the plunger in. More simply, a solenoid converts electrical energy into mechanical work.

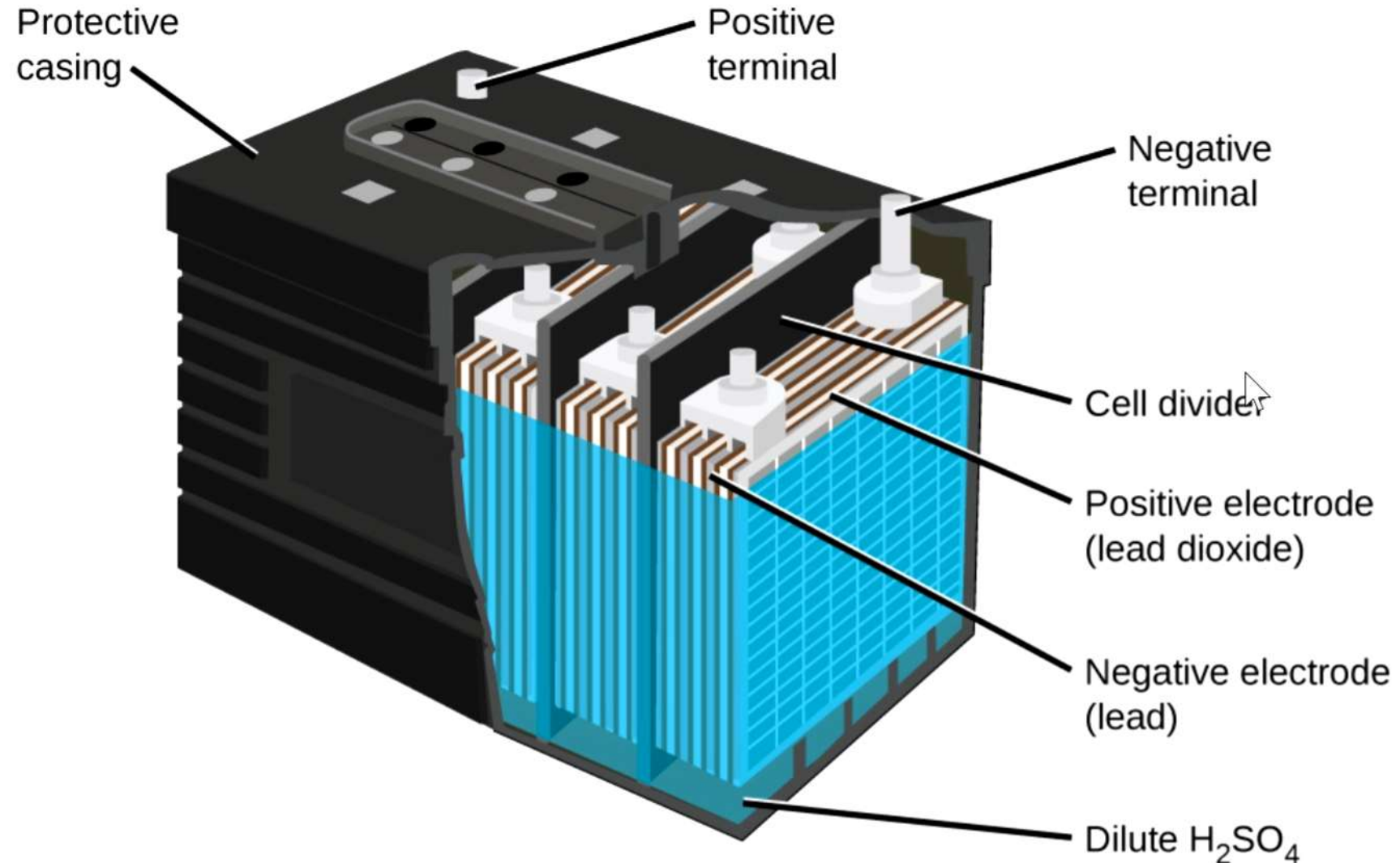


Conductors and Insulators

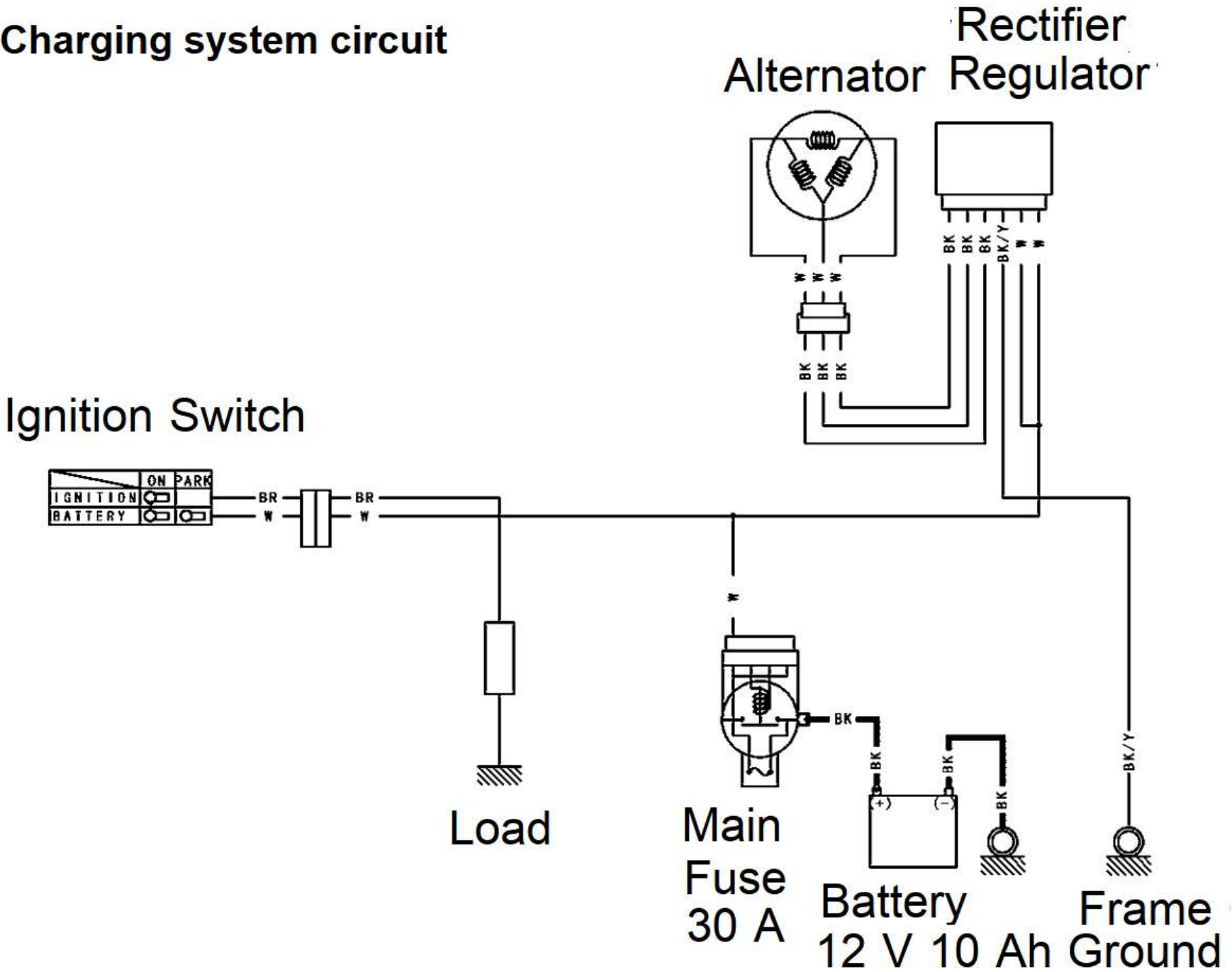
Sr. No.	Conductors	Insulators
1	The materials which allow the electric current or any energy to pass through it. Also, its magnetic field stores energy.	The materials which do not allow the electric current or any energy to pass through it. Its magnetic field does not store any energy.
2	Electrons move freely and the thermal conductivity is very high whereas the resistivity is very low with a weak covalent bond.	Electrons do not move freely and the thermal conductivity is very low whereas the resistivity is very high with the strong covalent bond.
3.	It has the positive temperature coefficient and the valence band remains empty.	It has a negative temperature coefficient and the valence band is occupied with full of electrons.
4.	Silver, copper, aluminium, irons are conductors.	Rubber, wood, paper, glass, plastics are the insulators.

Basic Charging System

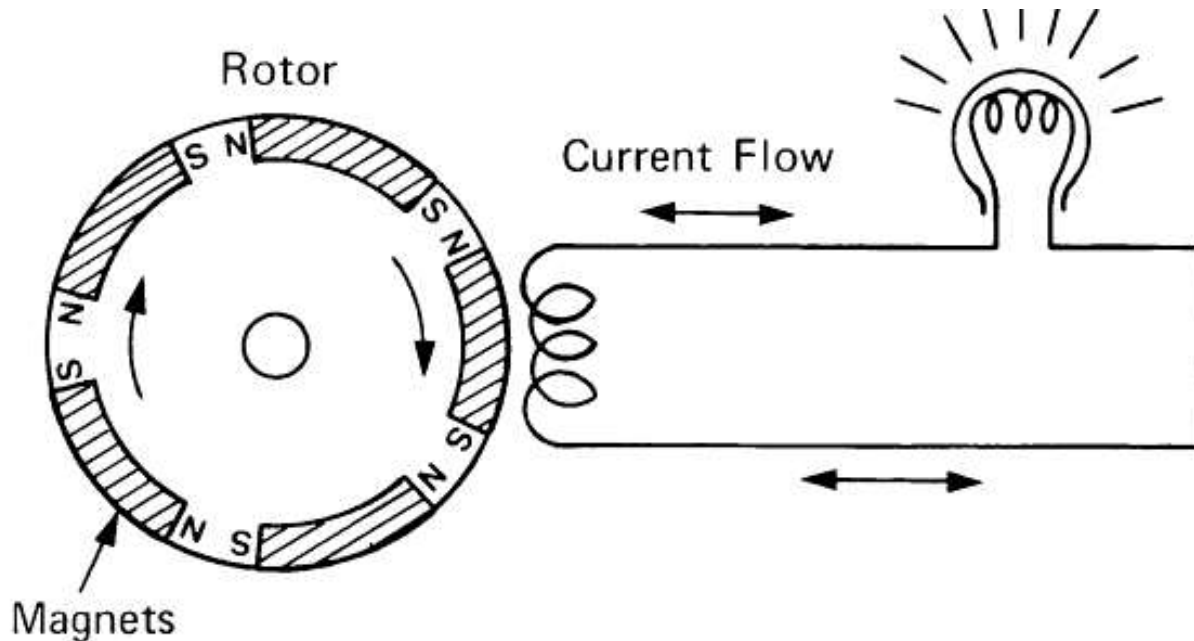
- **Battery:** A lead acid battery is a rechargeable battery that uses lead and sulphuric acid to function. The lead is submerged into the sulphuric acid to allow a controlled chemical reaction. This chemical reaction is what causes the battery to produce electricity



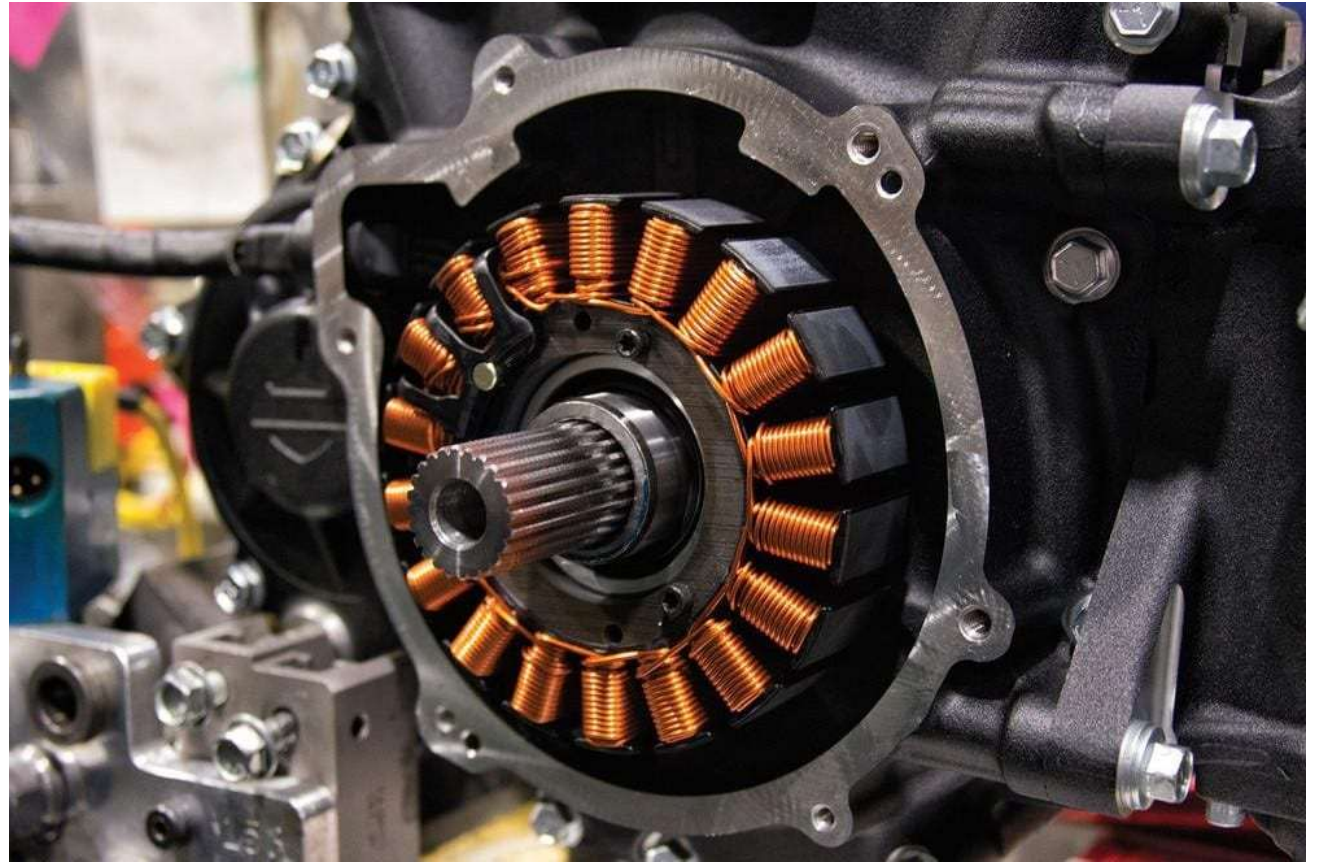
Charging system circuit



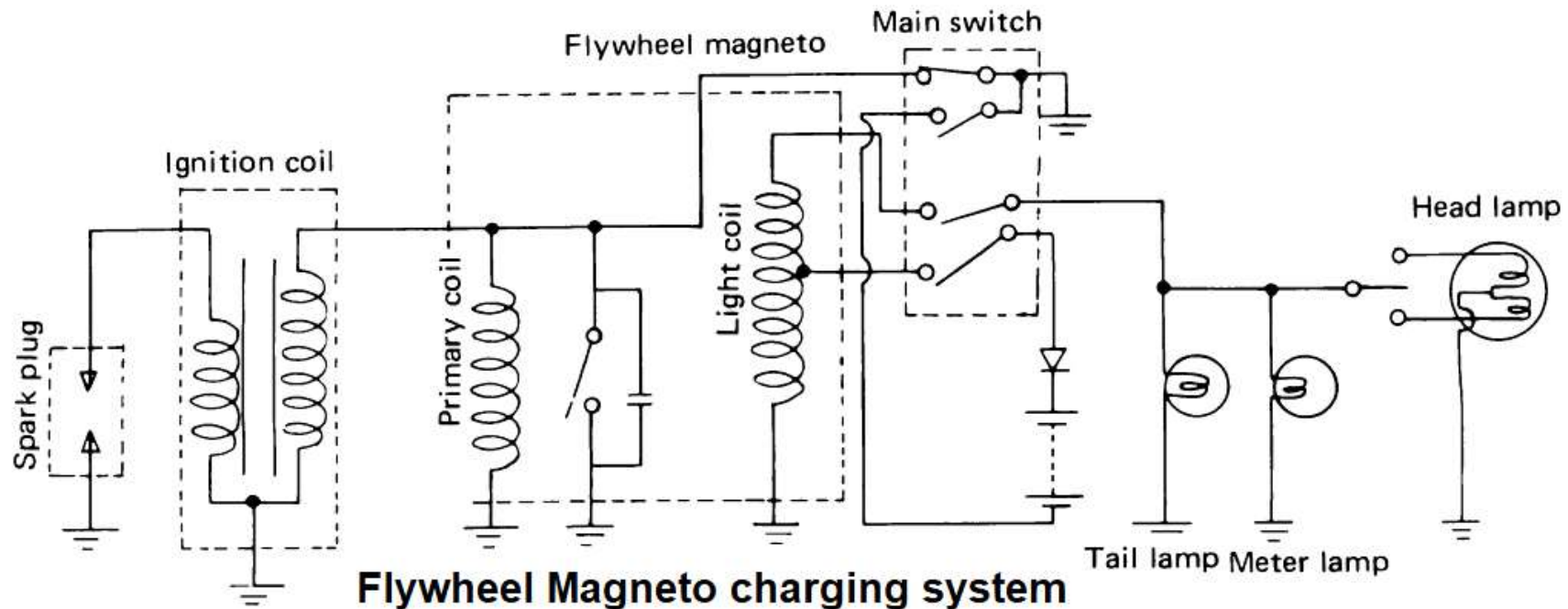
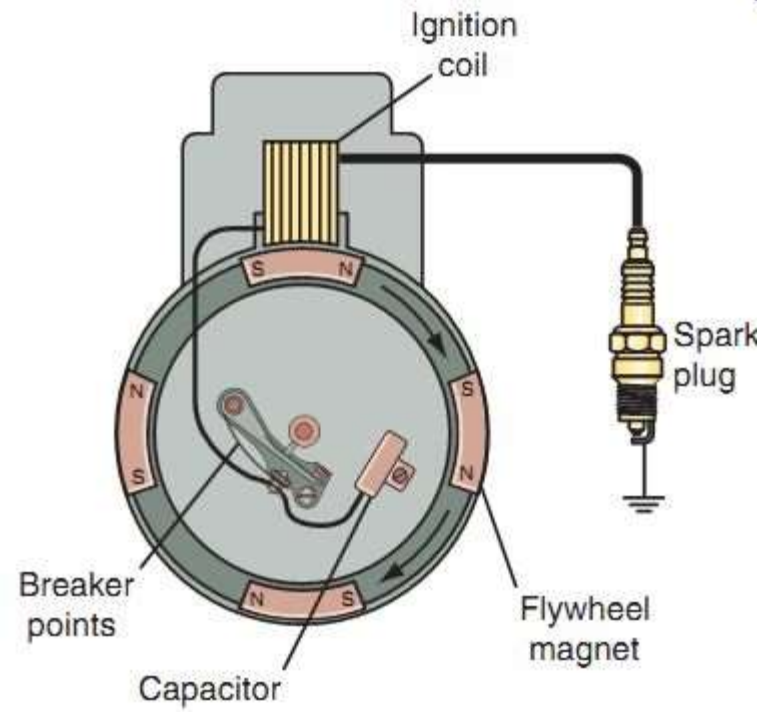
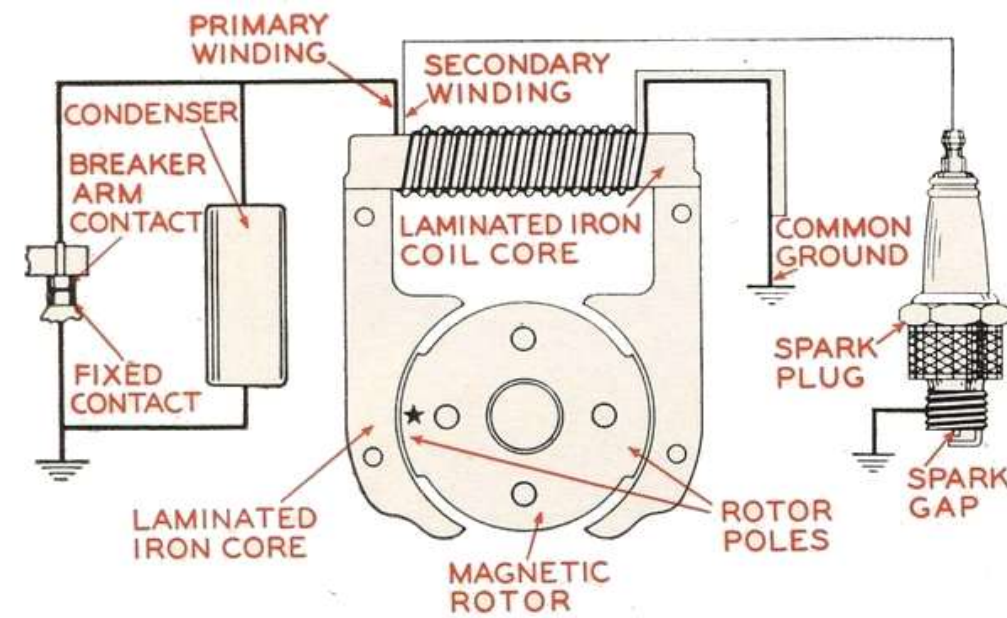
- An **alternator** is a type of electric generator used in modern motorcycle to charge the battery and to power the electrical system when its engine is running. The alternators that use permanent magnets are specifically called magnetos,



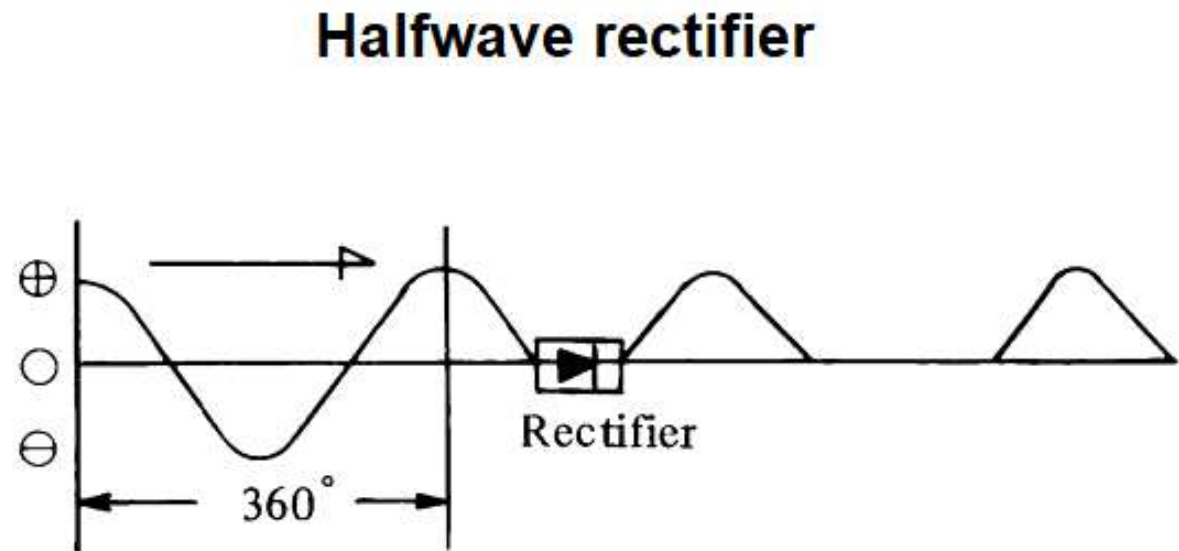
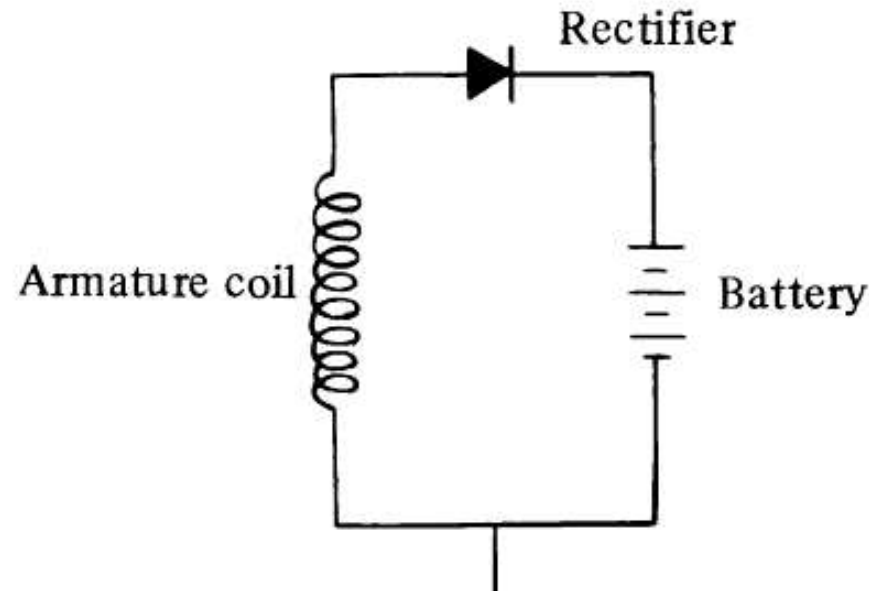
- A “**motorcycle stator**” is one component of the system that generates power for a motorcycle.



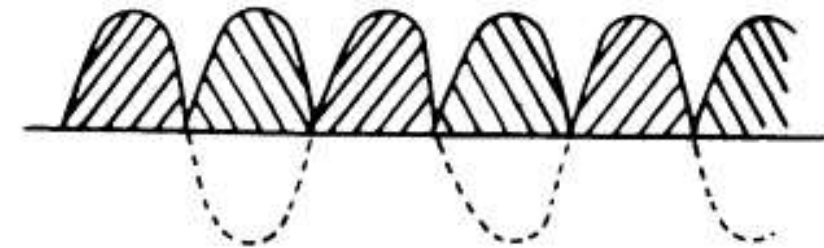
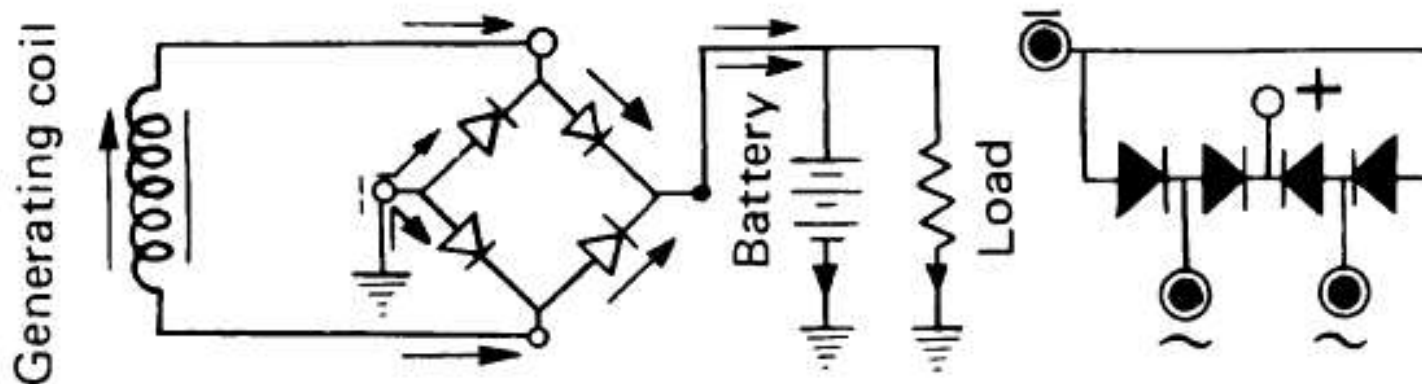
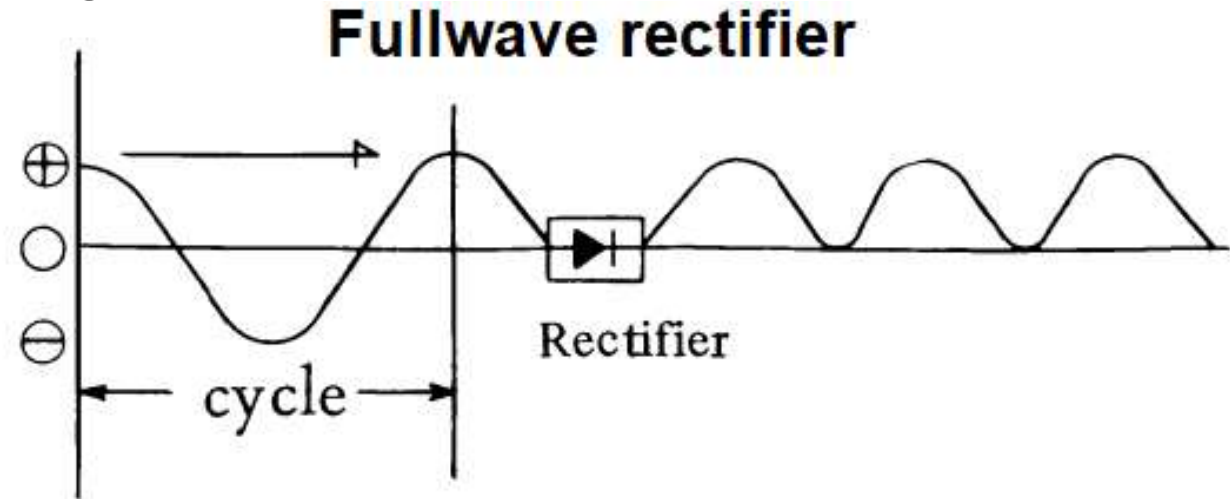
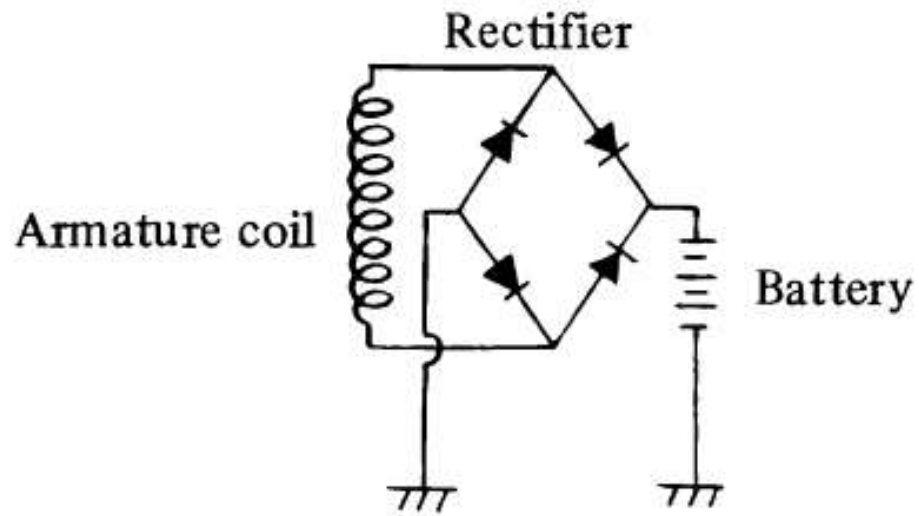
- Magneto** The magneto is a self-contained generator of high voltage that provides ignition to an engine through spark plugs. A magnet hence magneto spins in close proximity to a coil of wire. As the magnet spins (or the magnet rotor is turned), it generates a strong magnetic force that is “held back” by a primary coil.



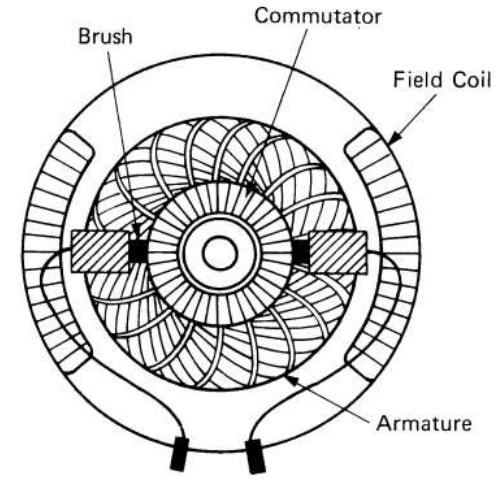
- **Rectifier:** A rectifier is an electrical component that converts alternating current (AC) to direct current (DC). A rectifier is analogous to a one-way valve that allows an electrical current to flow in only one direction. The process of converting AC current to DC current is known as rectification.
- **Half-wave rectification**
- In half-wave rectification of a single-phase supply, either the positive or negative half of the AC wave is passed, while the other half is blocked. Because only one half of the input waveform reaches the output, mean voltage is lower. Half-wave rectification requires a single diode in a single-phase supply



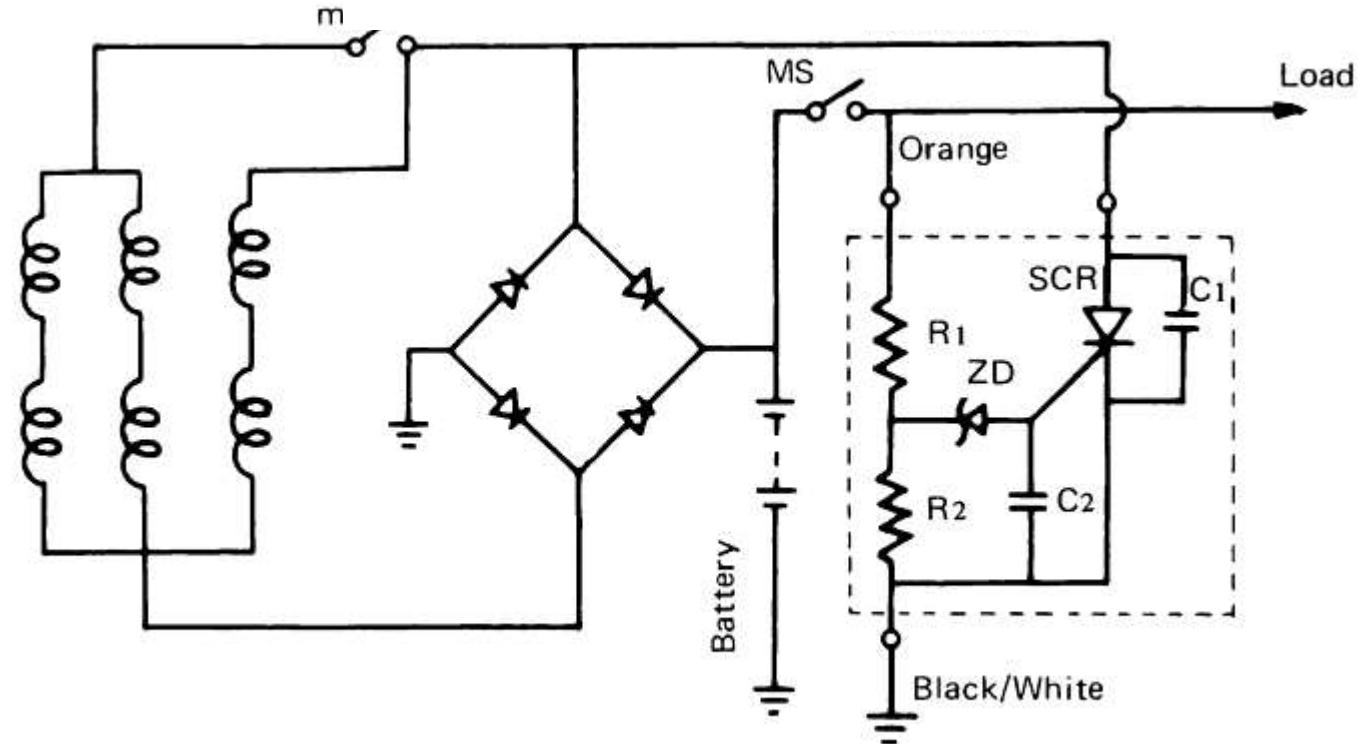
- **Full-wave rectification** rectifies the negative component of the input voltage to a positive voltage, then converts it into DC (pulse current) utilizing a diode bridge configuration. In contrast, half-wave rectification removes just the negative voltage component using a single diode before converting to DC



- A **generator** on a bike is producing this electrical power because it has a copper wire winding on the stator (the static part of the generator) that is located inside a varying magnetic field. The simplest generator uses a flywheel that runs on the crankshaft with a couple of magnets inside it

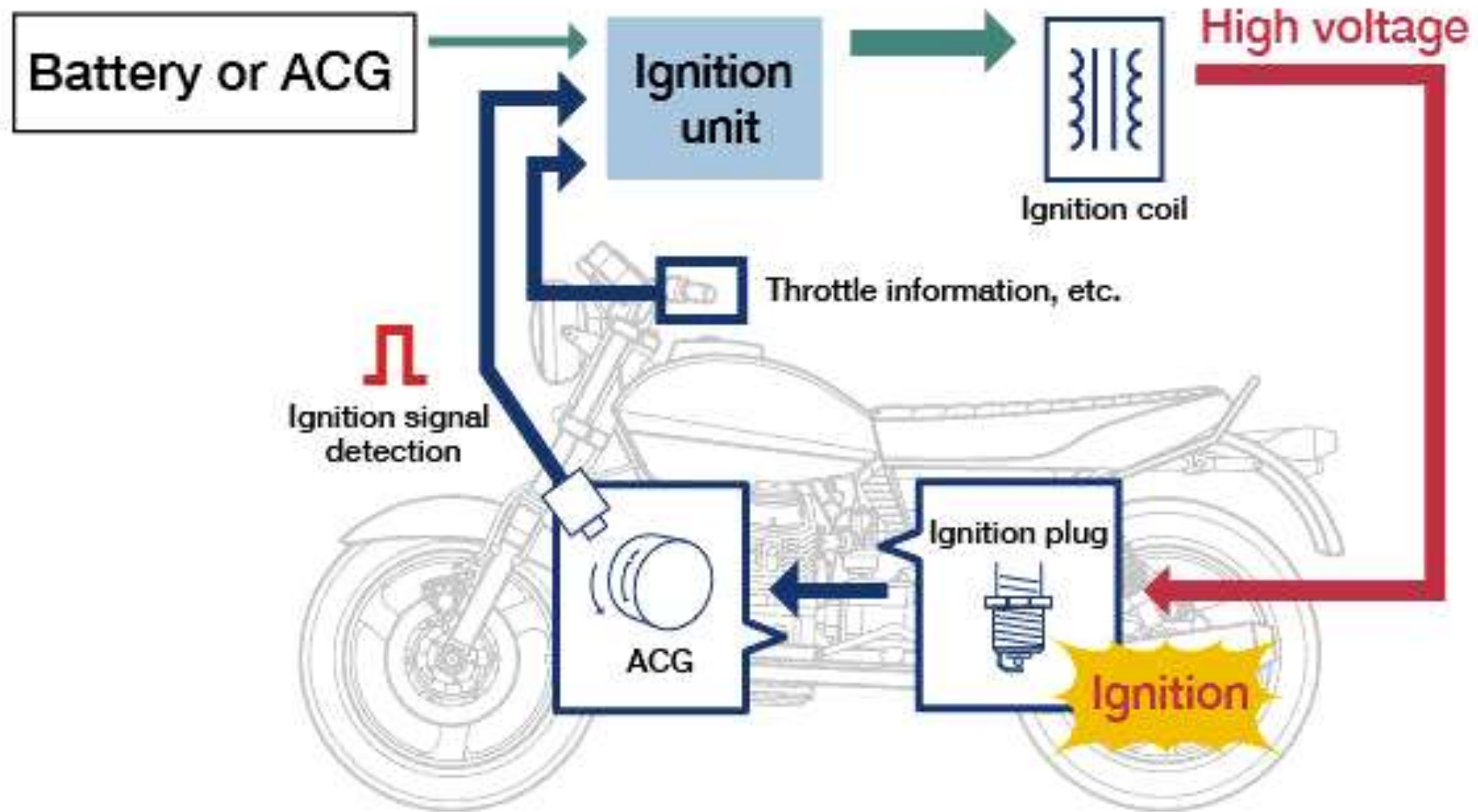


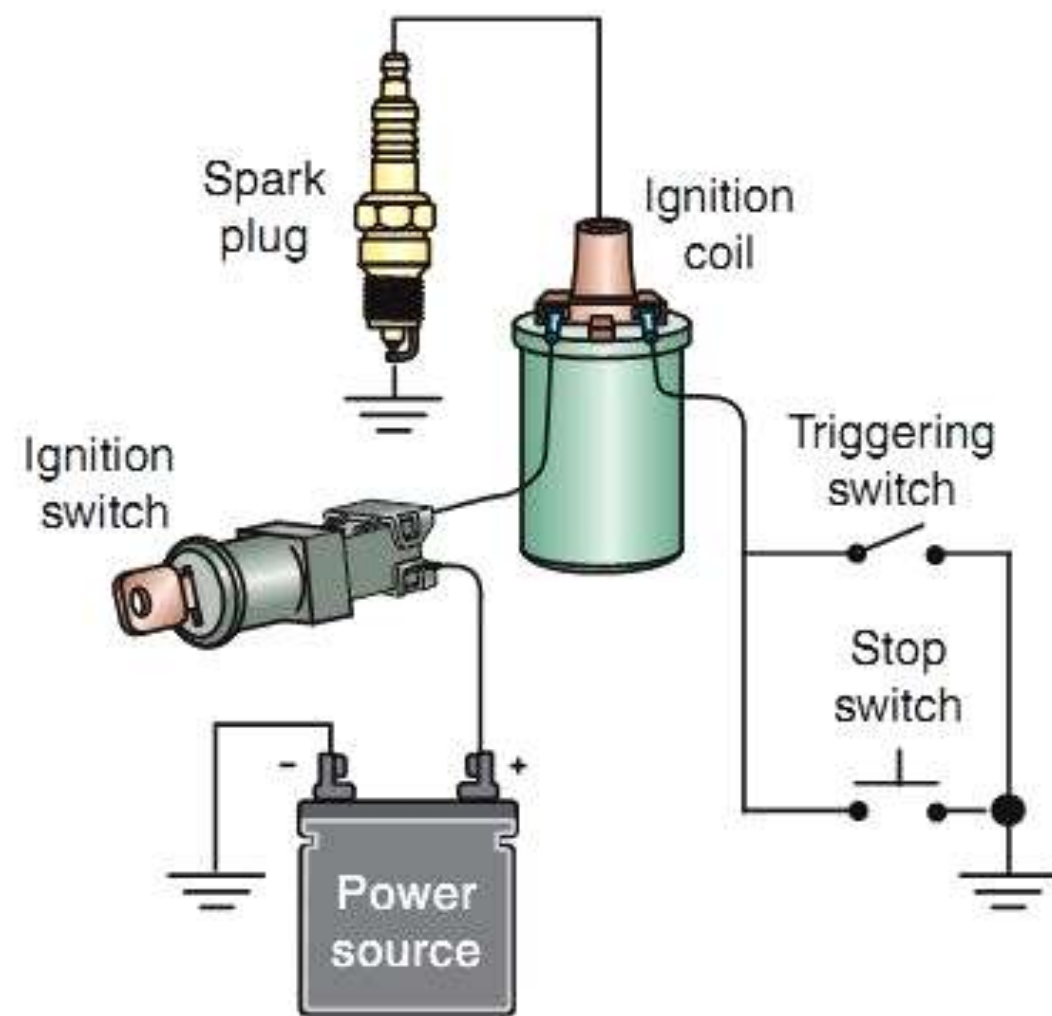
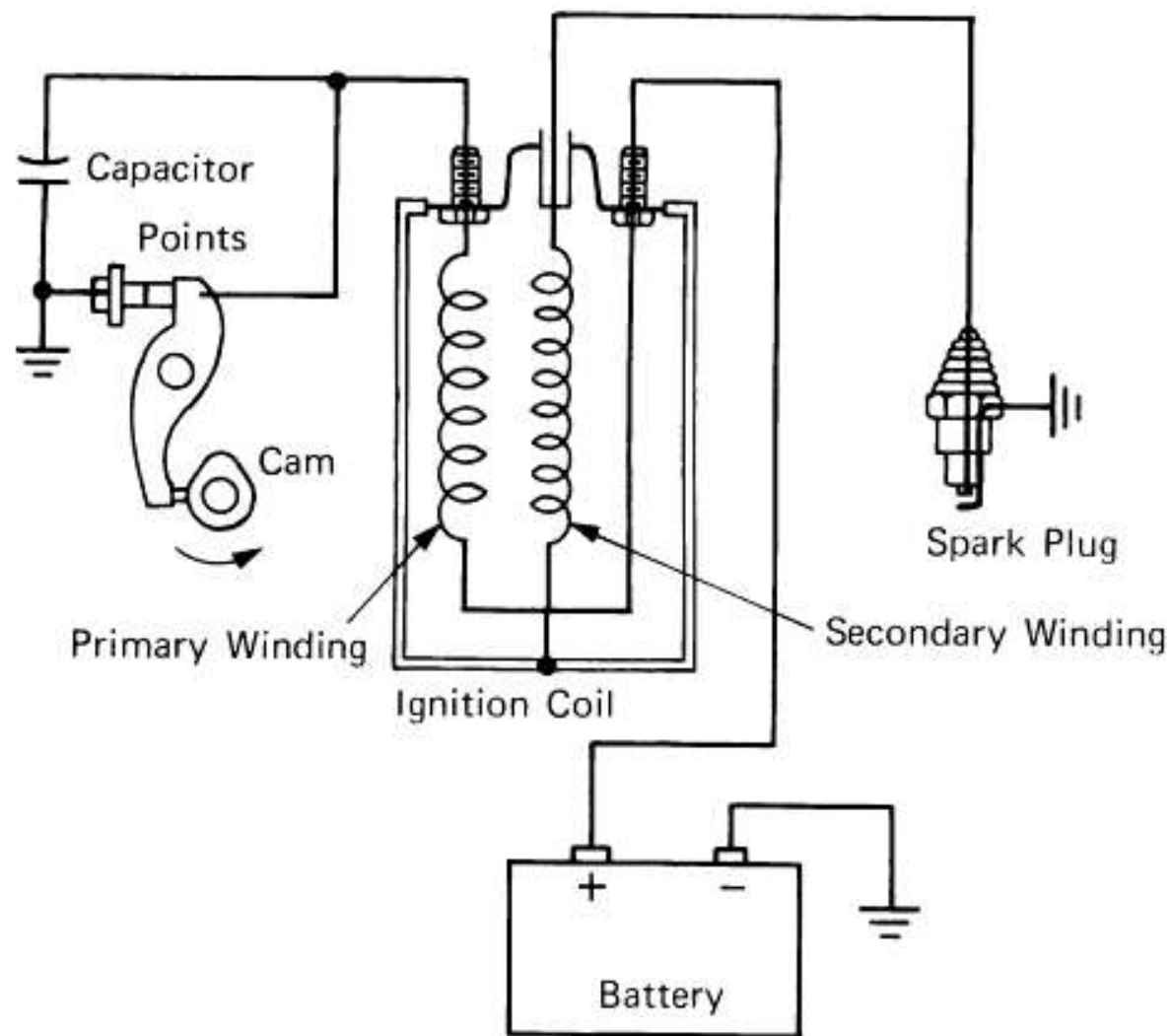
D.C generator



AC generator schematic Showing generator, rectifier, regulator

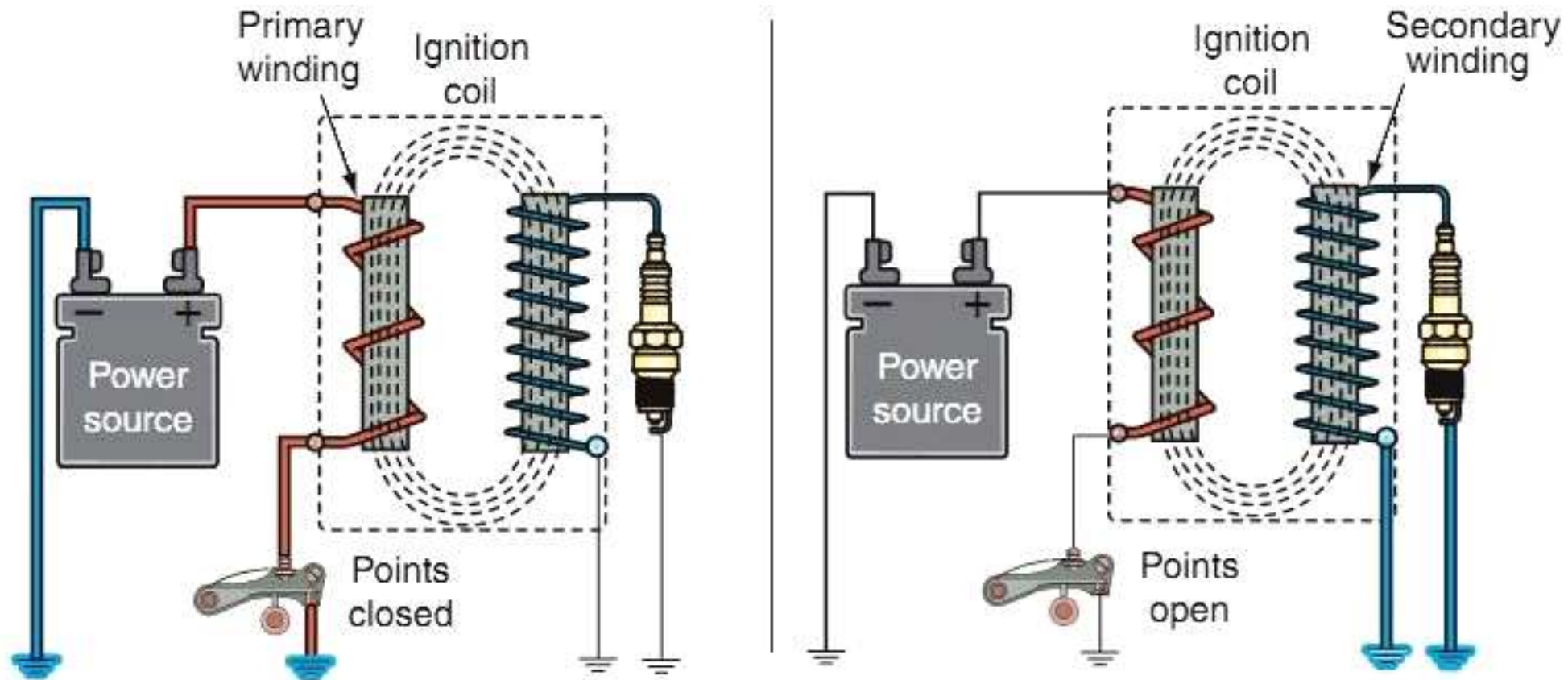
Ignition System



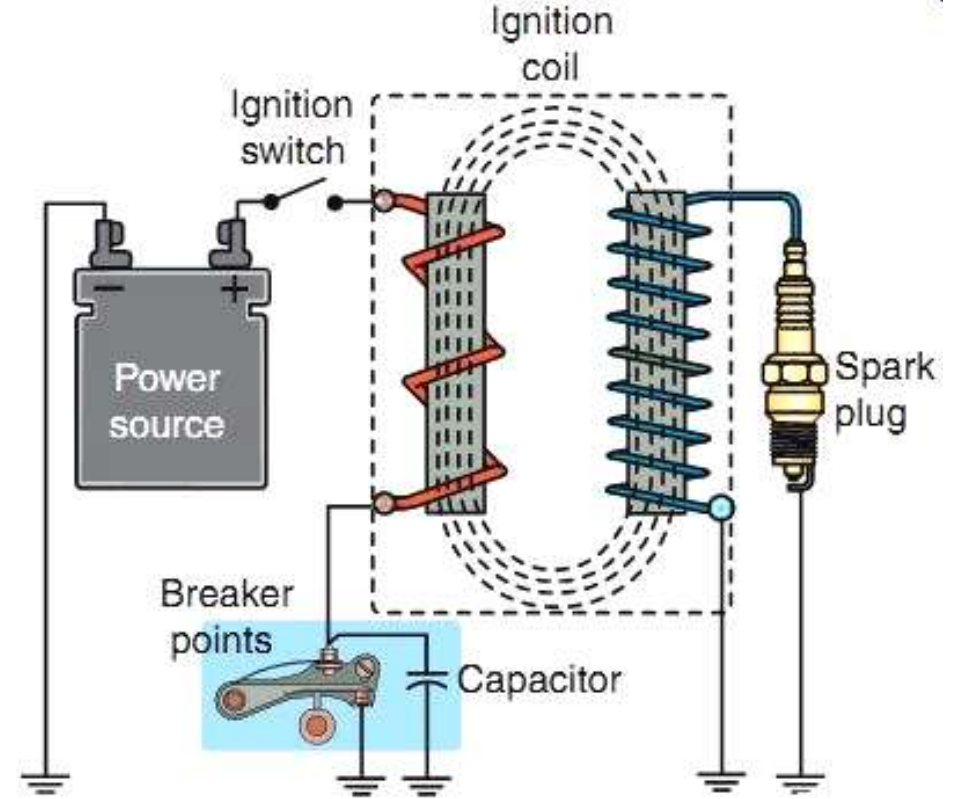


Wiring diagram of battery coil ignition system

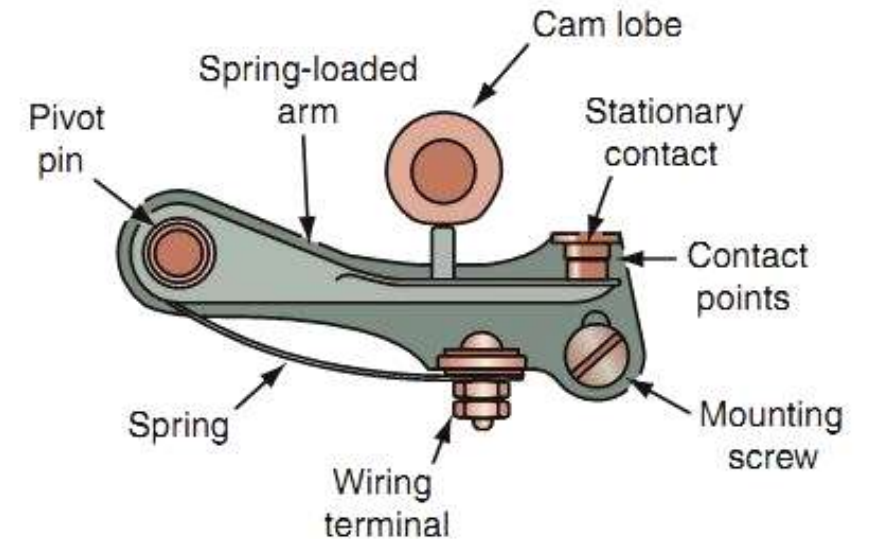
- As the engine rotates, the distributor shaft cam turns until the high point on the cam causes the breaker points to separate suddenly. Instantaneously, when the points open (separate) current flow stops through the primary windings of the ignition coil. This causes the magnetic field to collapse around the coil.



- A **capacitor** is a two-terminal electrical device that can store energy in the form of an electric charge.

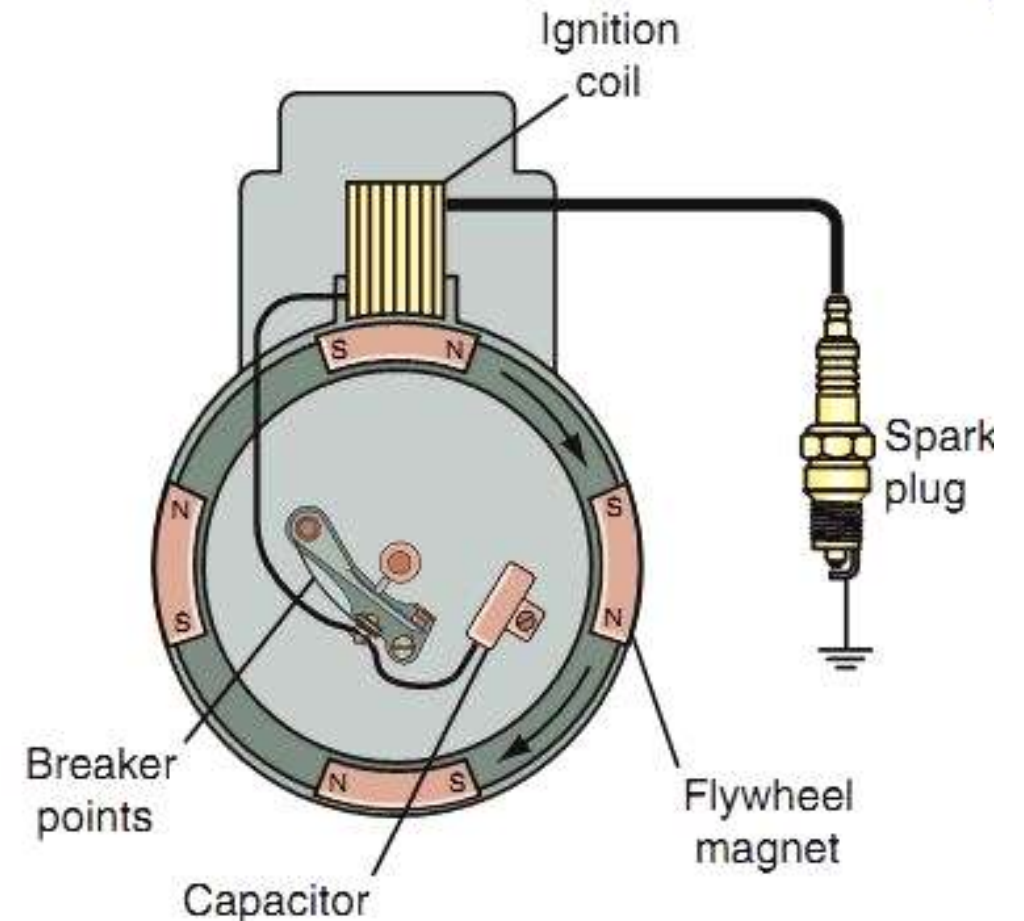
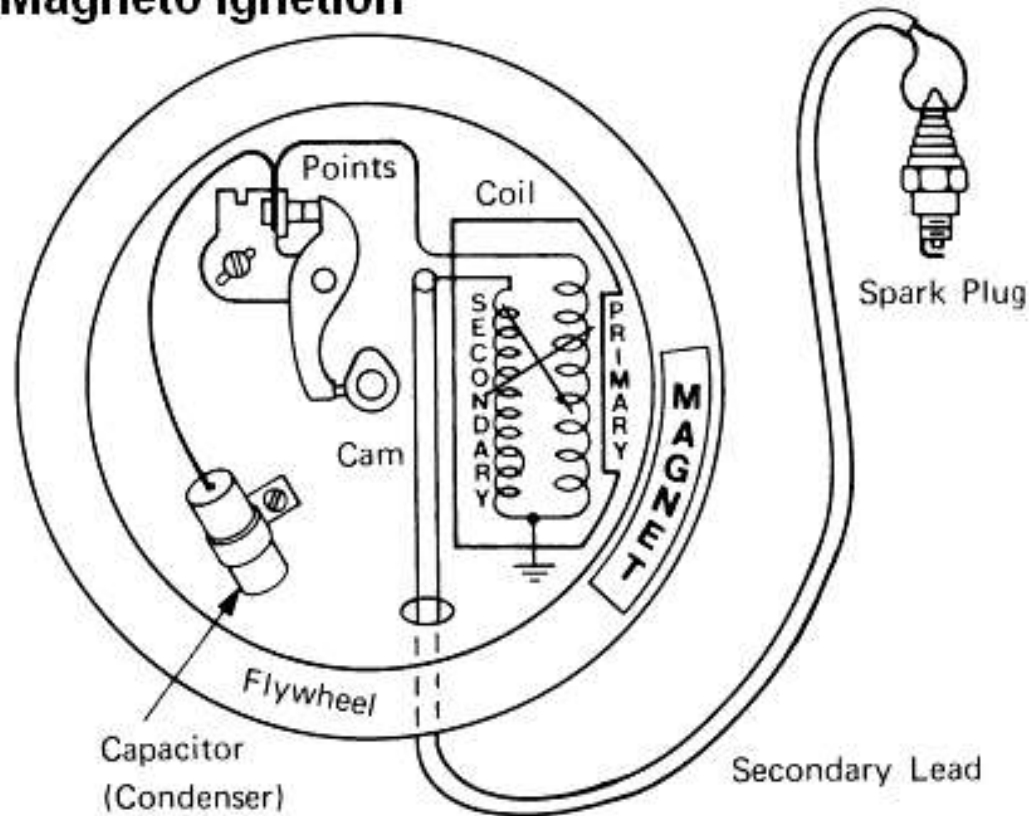


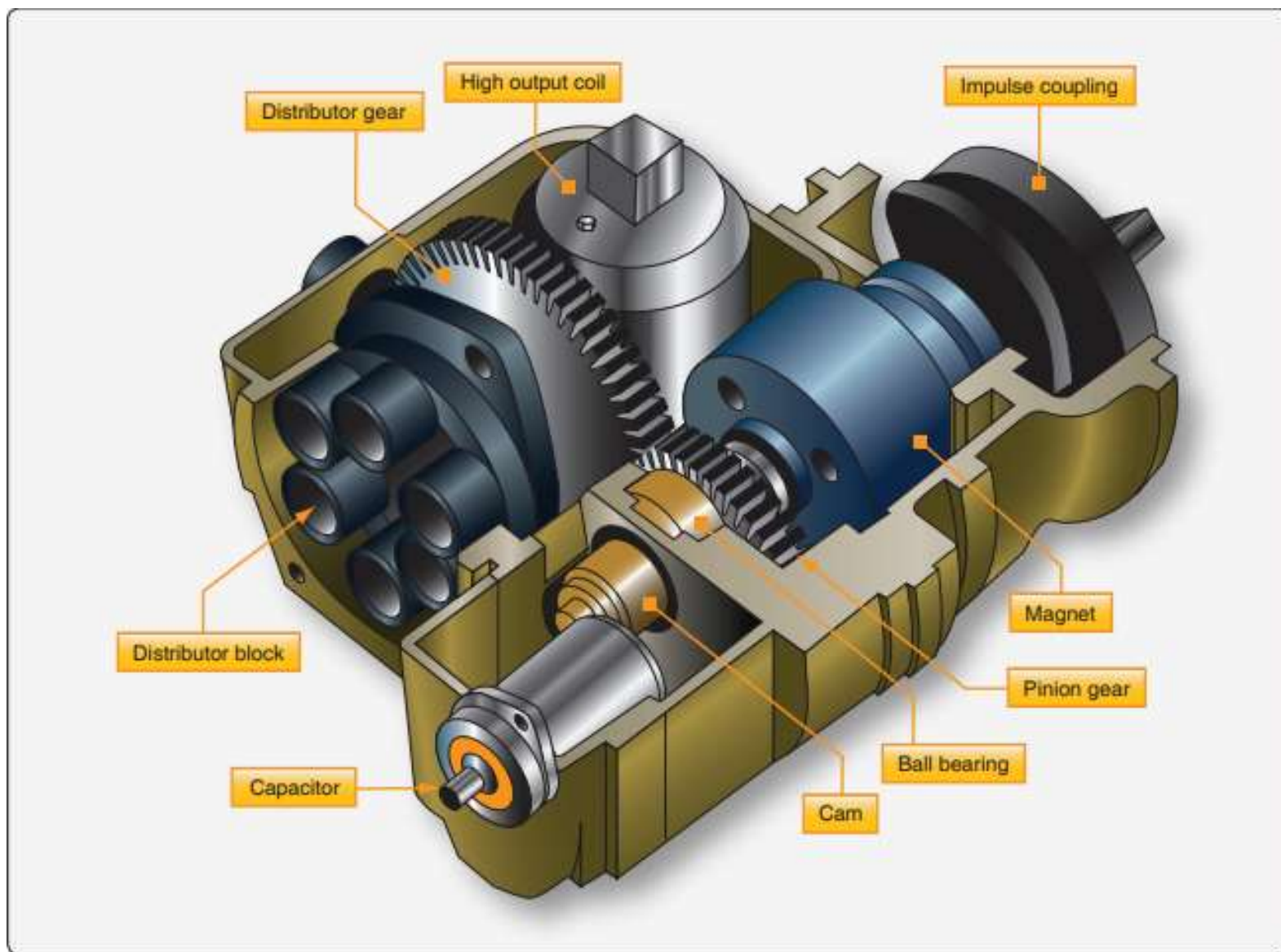
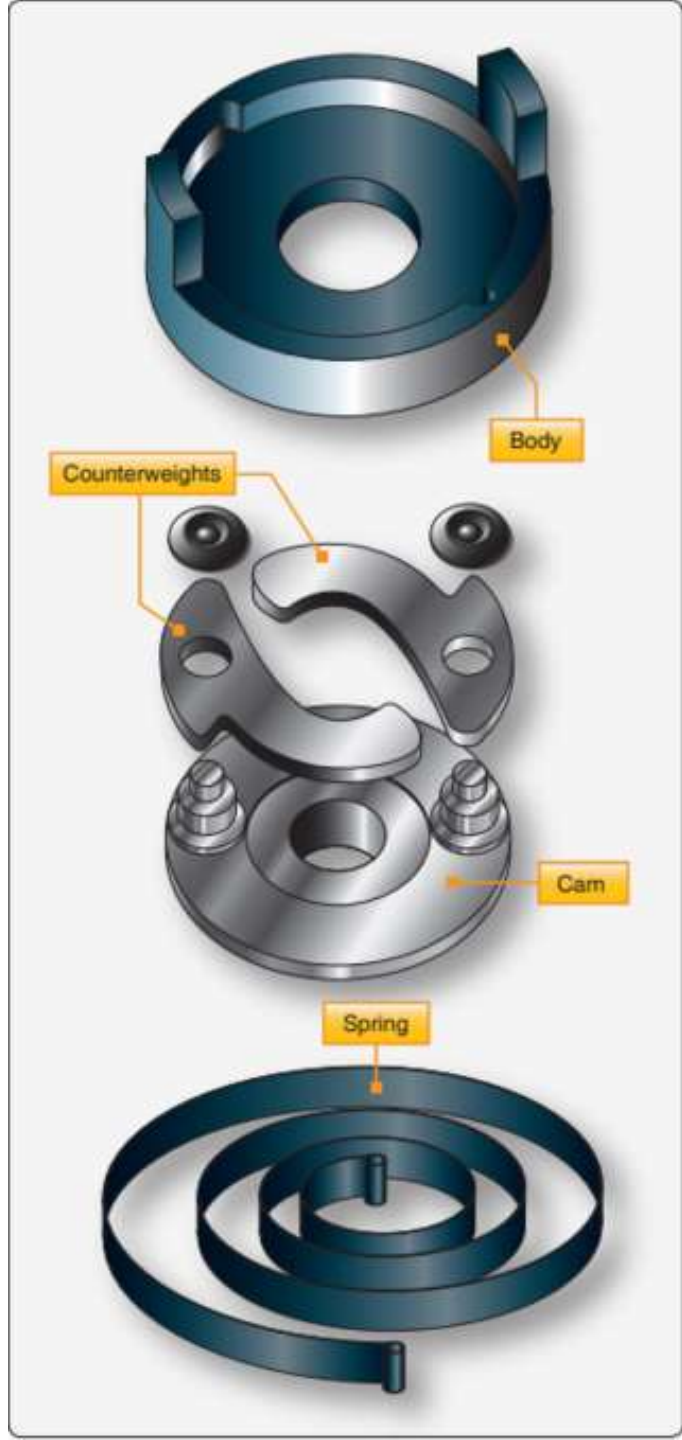
- A contact breaker (or "**points**") is a type of electrical switch, found in the **ignition** systems of spark **ignition** internal combustion engines

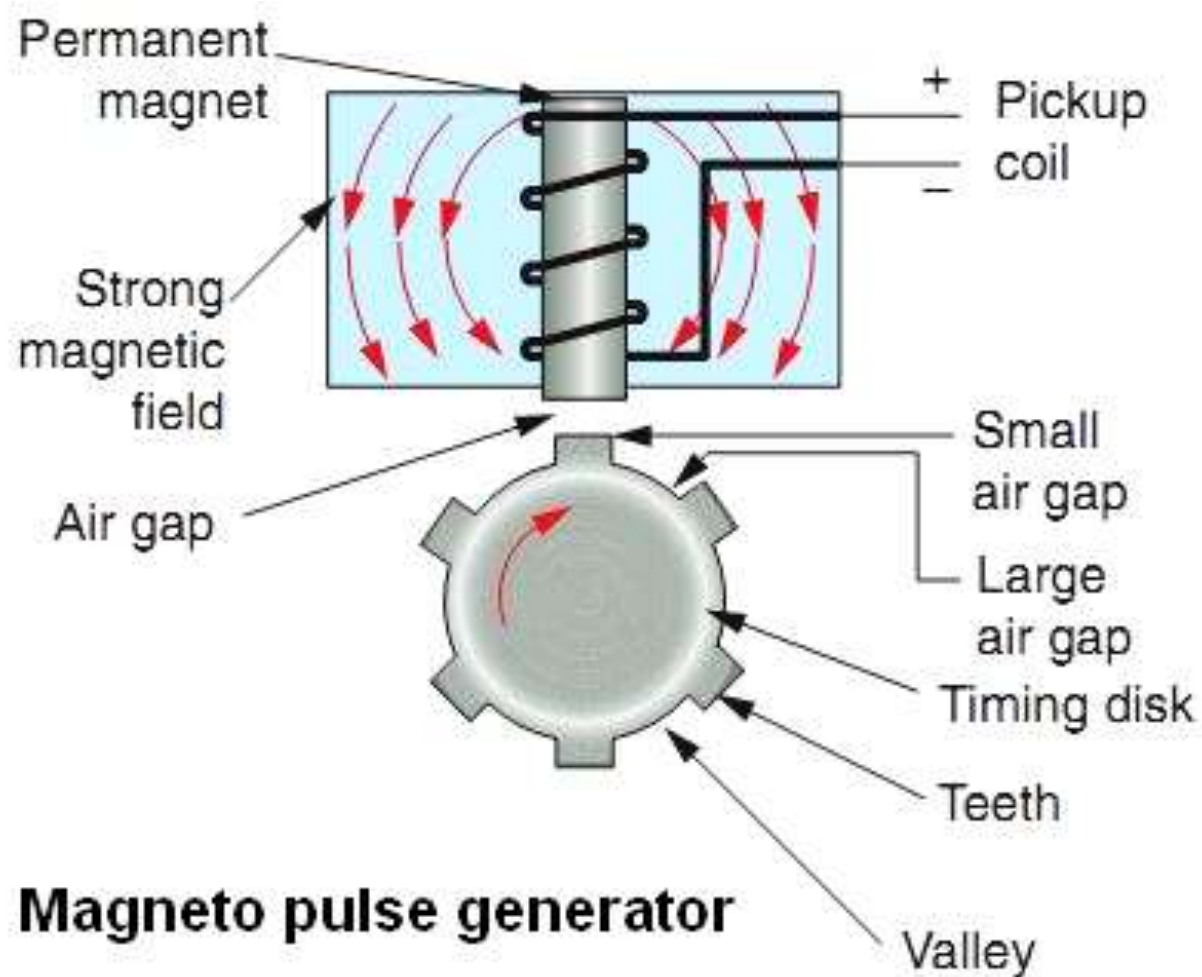
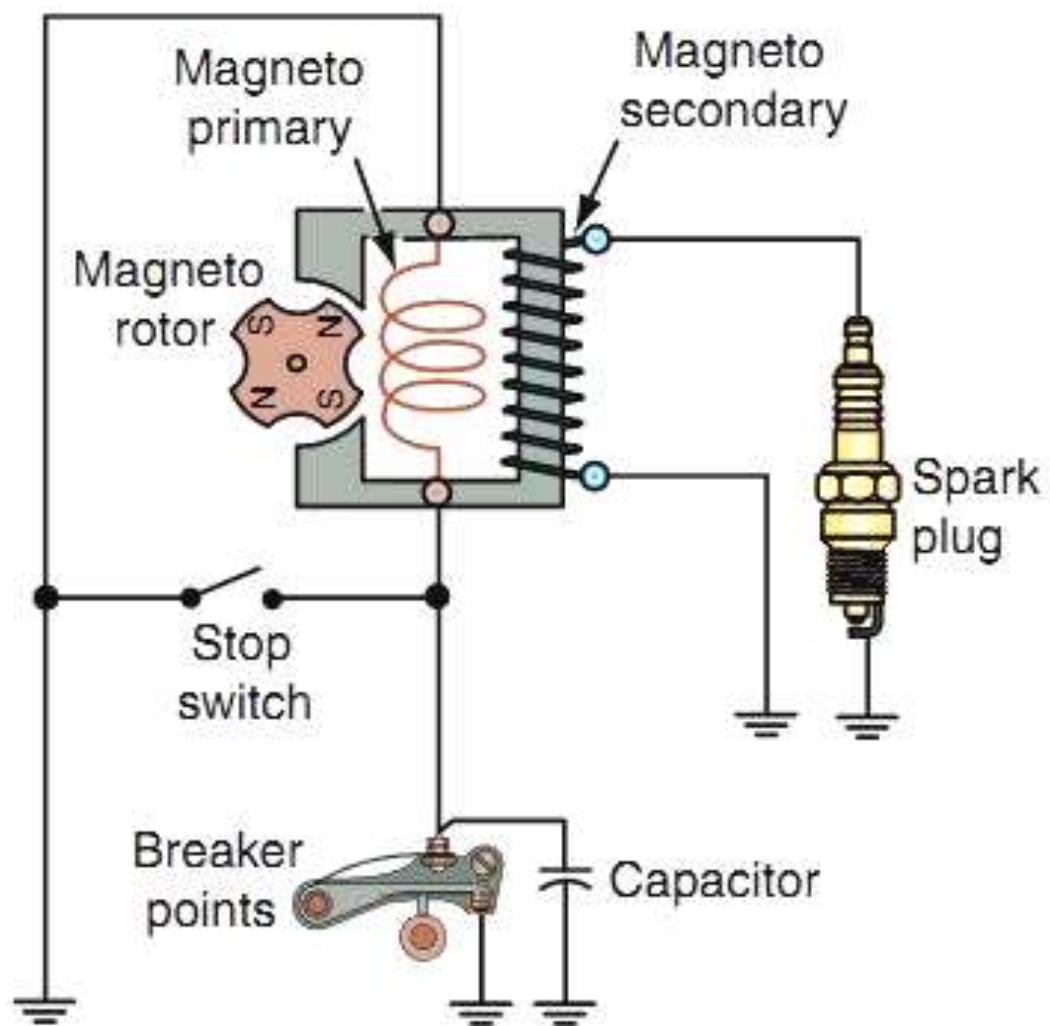


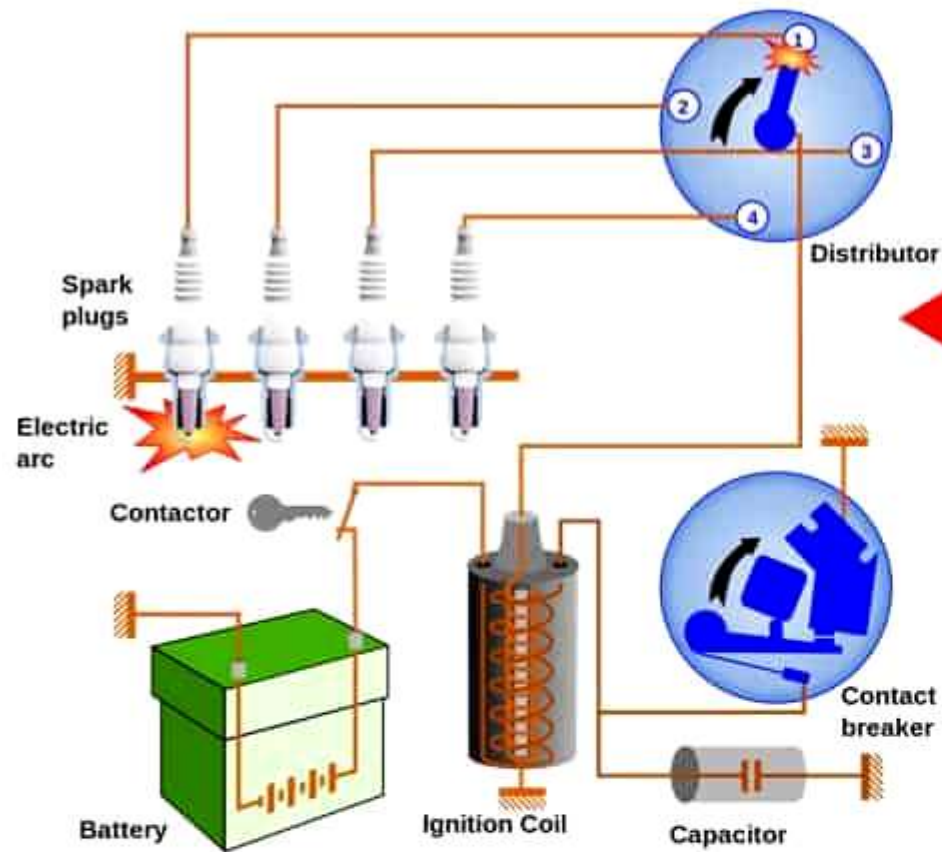
- **Magneto Ignition System** (also called a high-tension magneto) is an older type of ignition system used in spark-ignition engines (such as petrol engines). It uses a magneto and a transformer to make pulses of high voltage for the spark plugs. The older term "high-tension" means "high-voltage".

Magneto Ignition



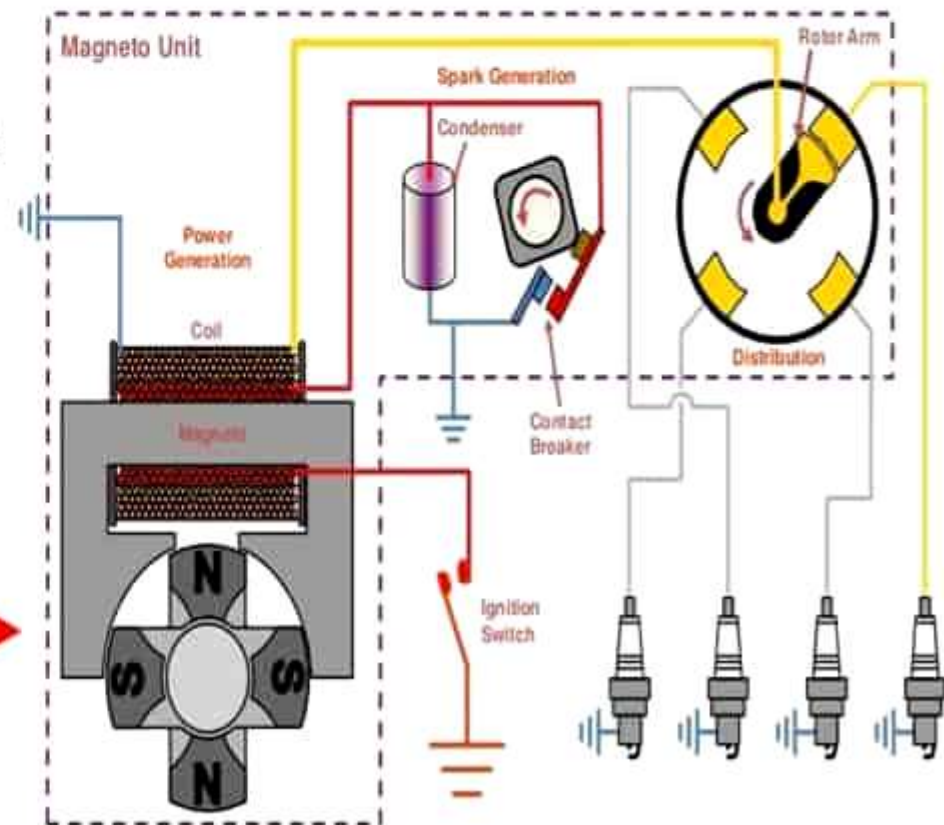






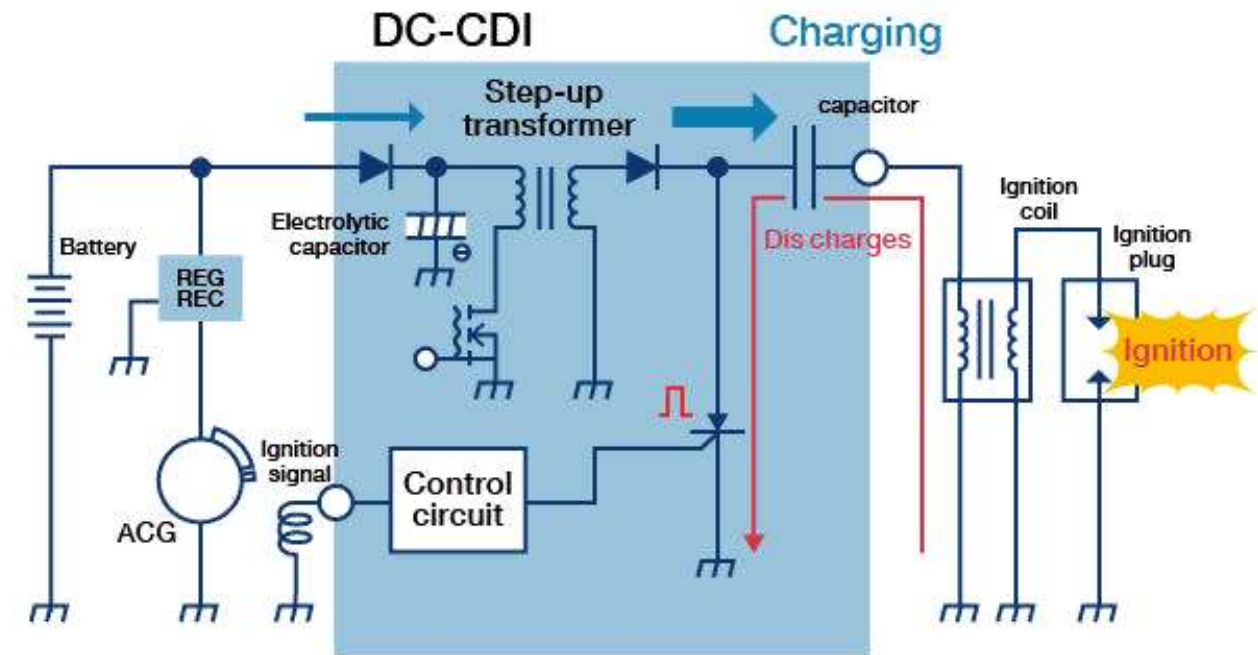
Battery Ignition System

Magneto Ignition System



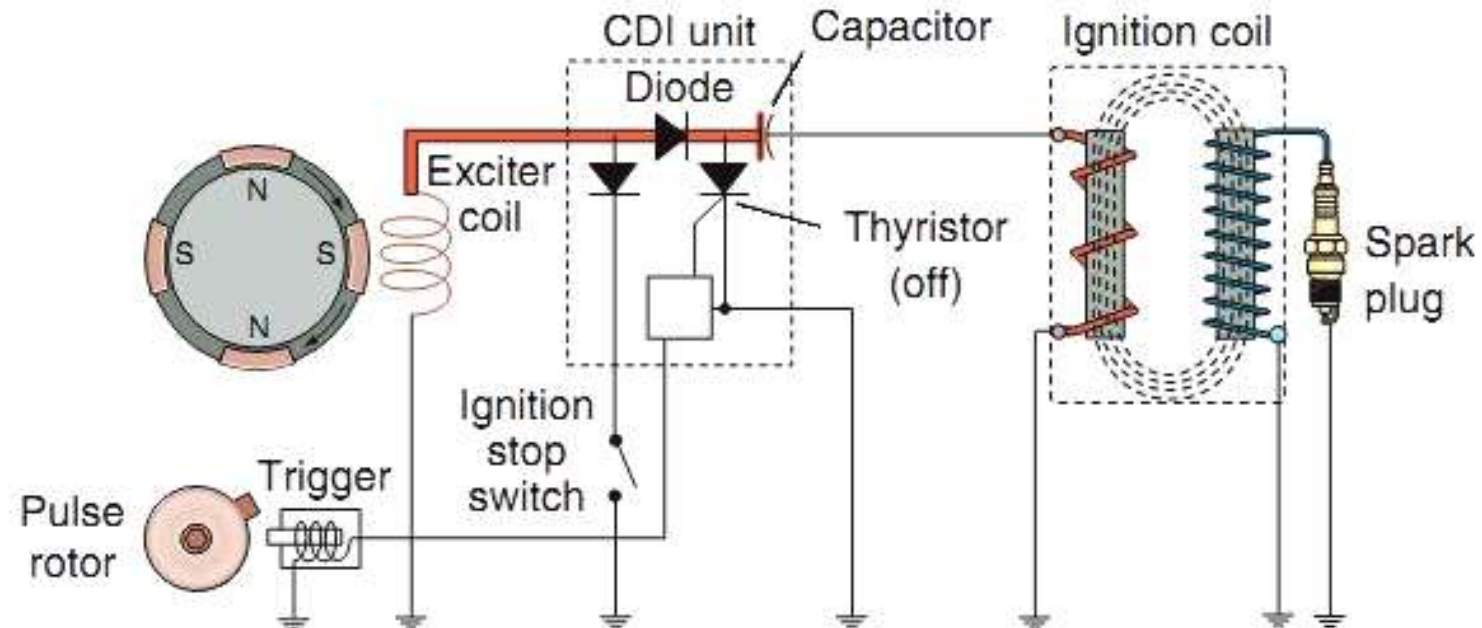
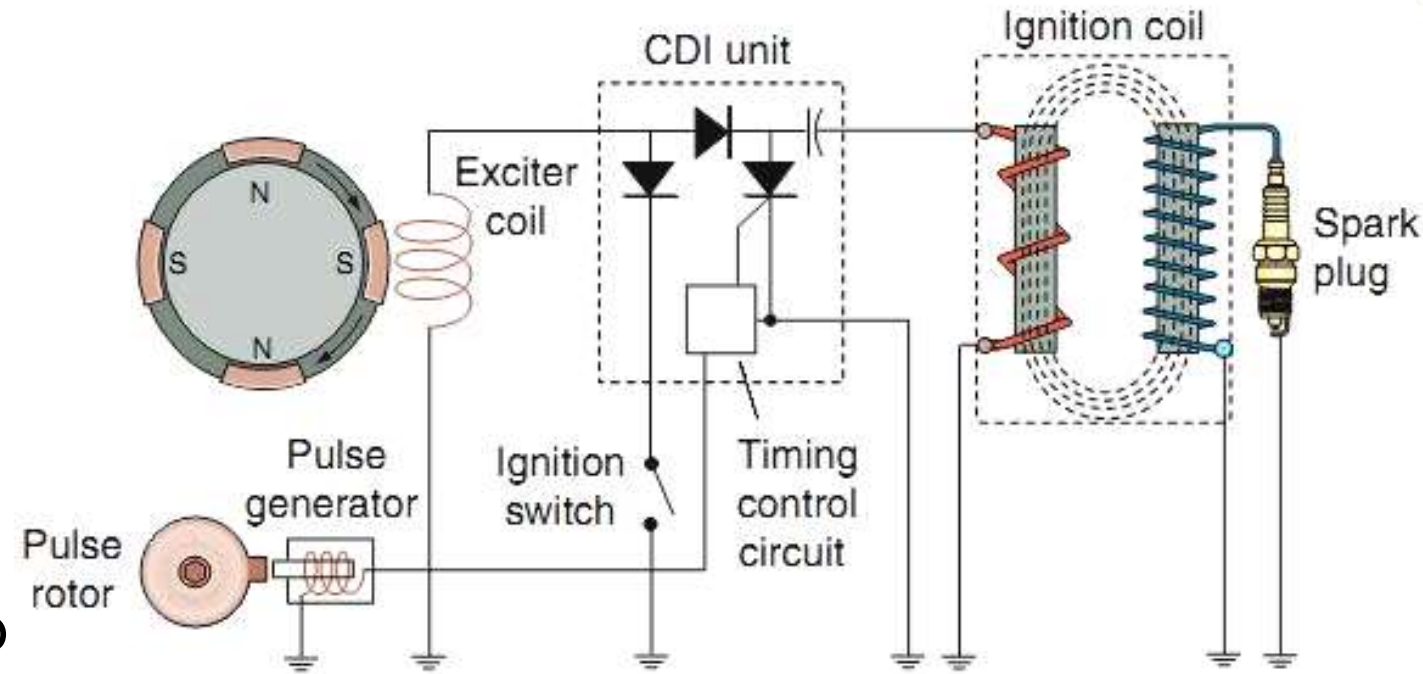
Electronic Ignition System

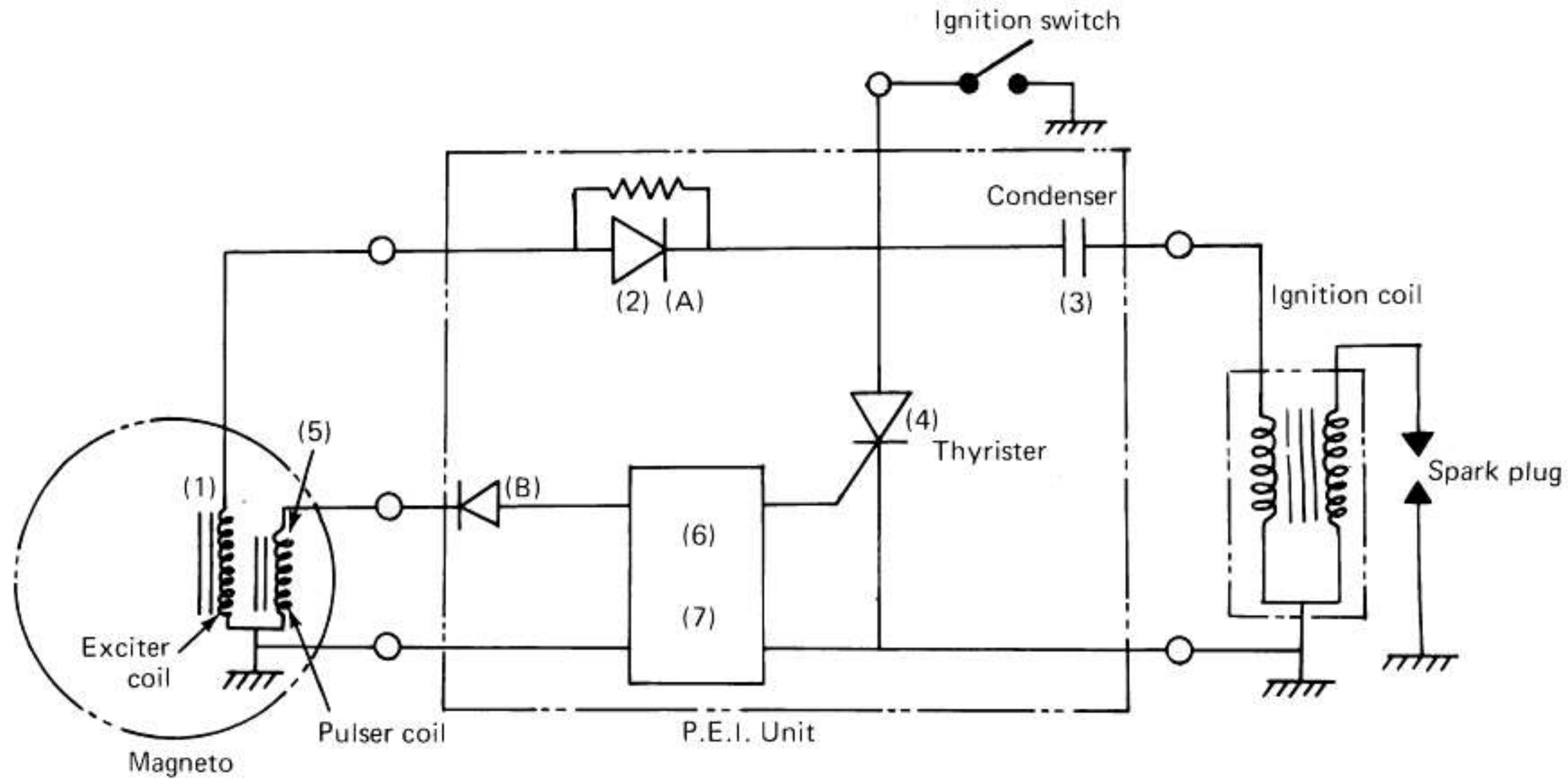
- An electronic ignition system on a motorcycle works by replacing the mechanical points and condenser that were commonly used in older vehicles with an electronic control module. This control module uses sensors to monitor the position of the engine's crankshaft and the spark plugs' firing, which it then uses to control the timing and delivery of spark to the engine's cylinders.



When it comes to ignition systems, you'll commonly hear of what's called a CDI box, or capacitor discharge ignition box. Essentially, a CDI box controls a motorcycle's ignition system by starting the ignition and combustion process. A pulse of voltage from the motorcycle battery passes through the CDI box to fire up the spark plug. In addition to the CDI box, other components of modern ignition systems include:

- Battery
- Coil
- Spark plugs/spark plug wires
- Switch
- Pickup coils or crank position sensors



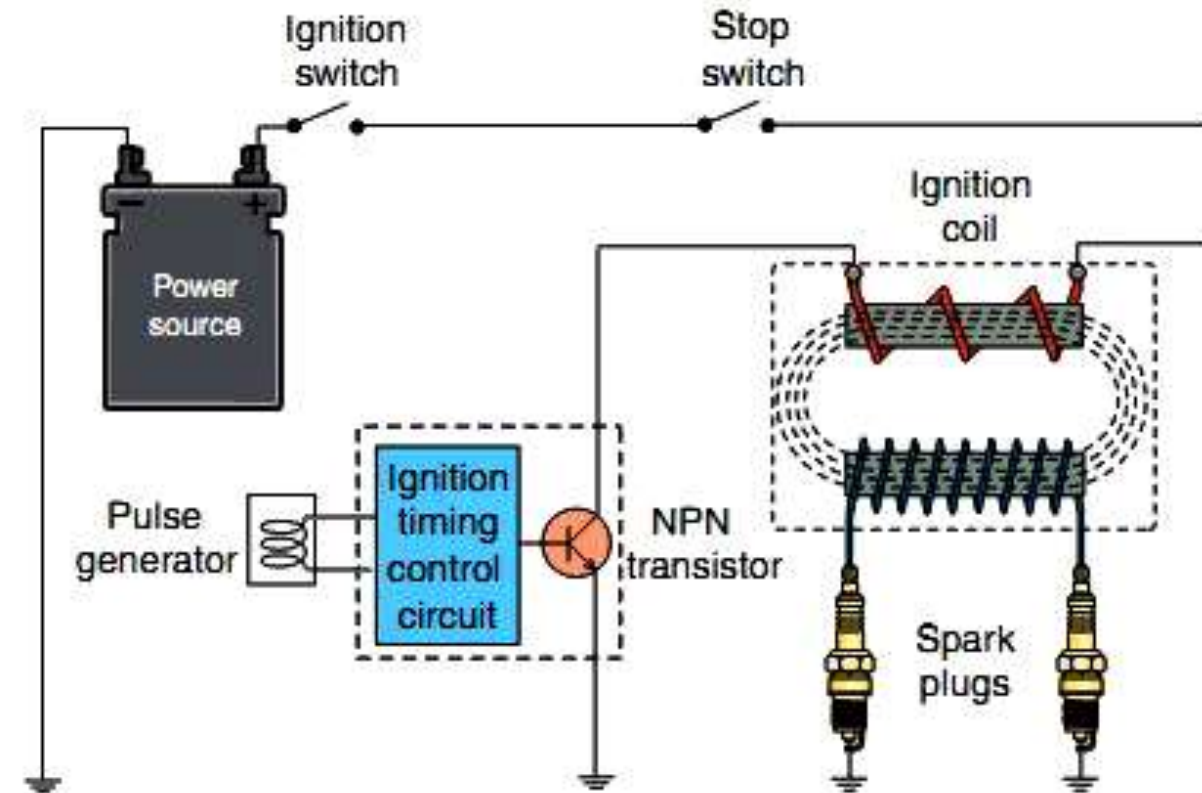


CDI Ignition System Diagram

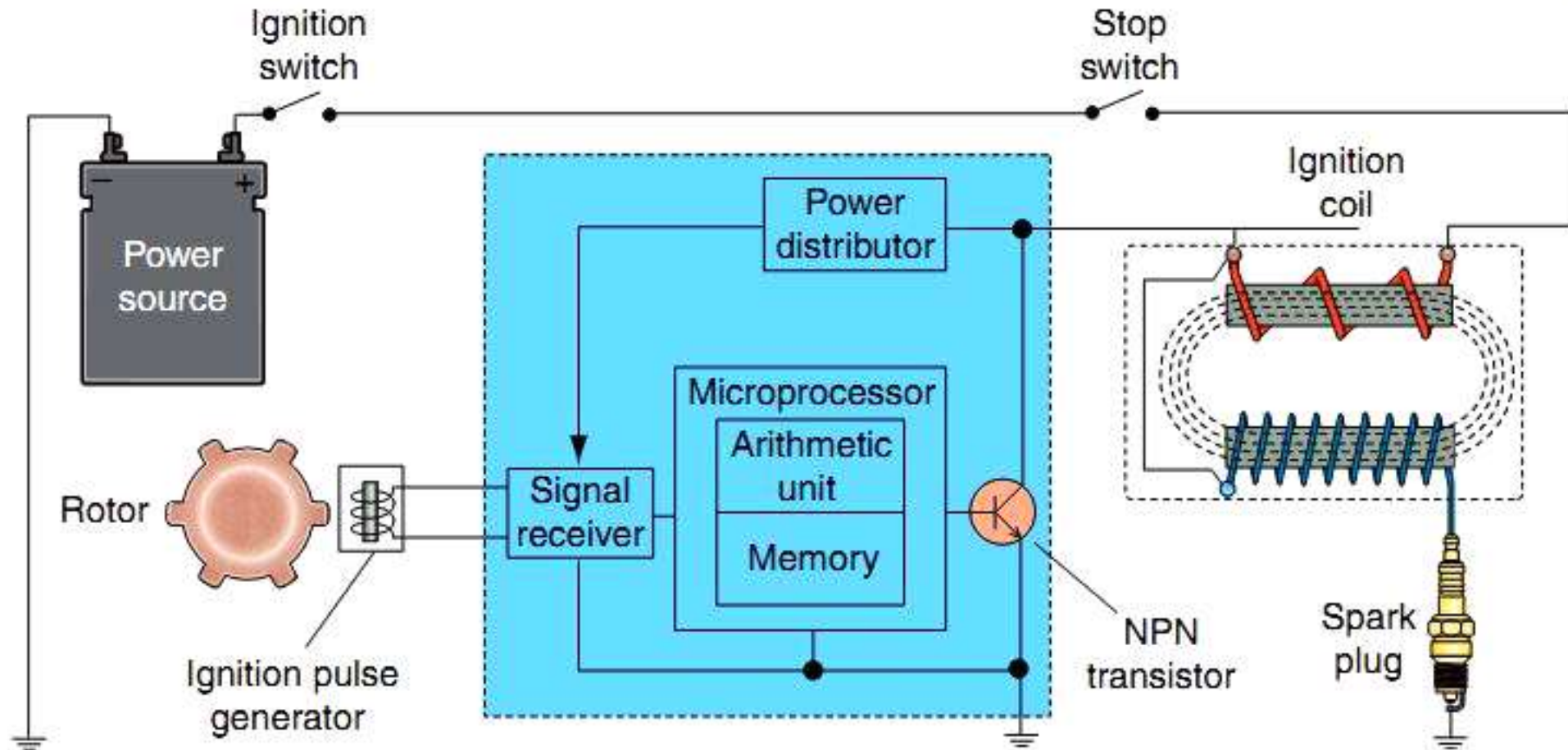
- **Transistorized Ignition System**

Transistorized ignition system is an ignition scheme that reduces the use of mechanical devices, the purpose of transistorized ignition system is to improve the efficiency of the ignition system performance by replacing moving parts such as breaker points.

The main principle of transistorized ignition systems is to use transistors as electronic switches instead of breaker points.

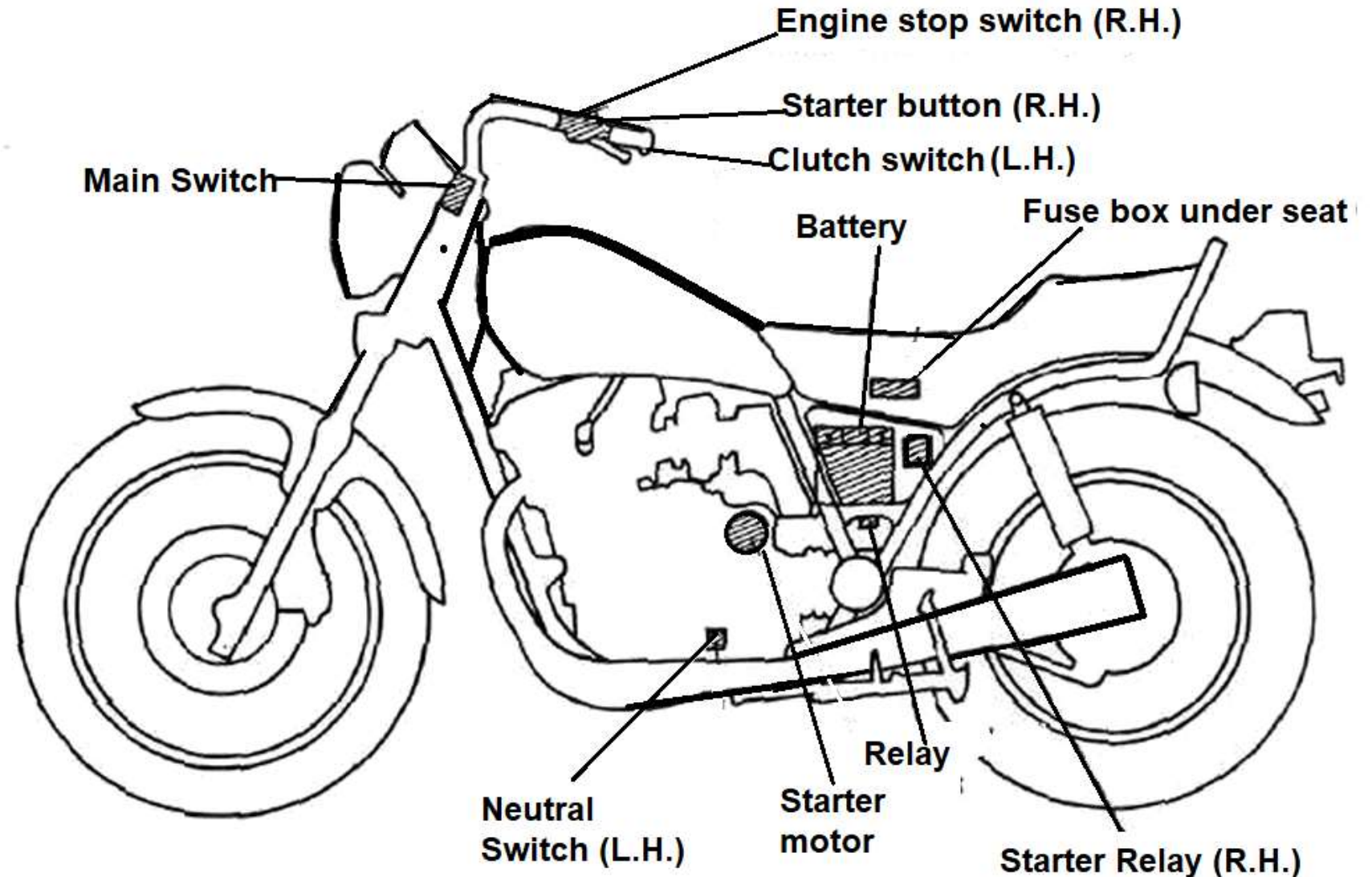


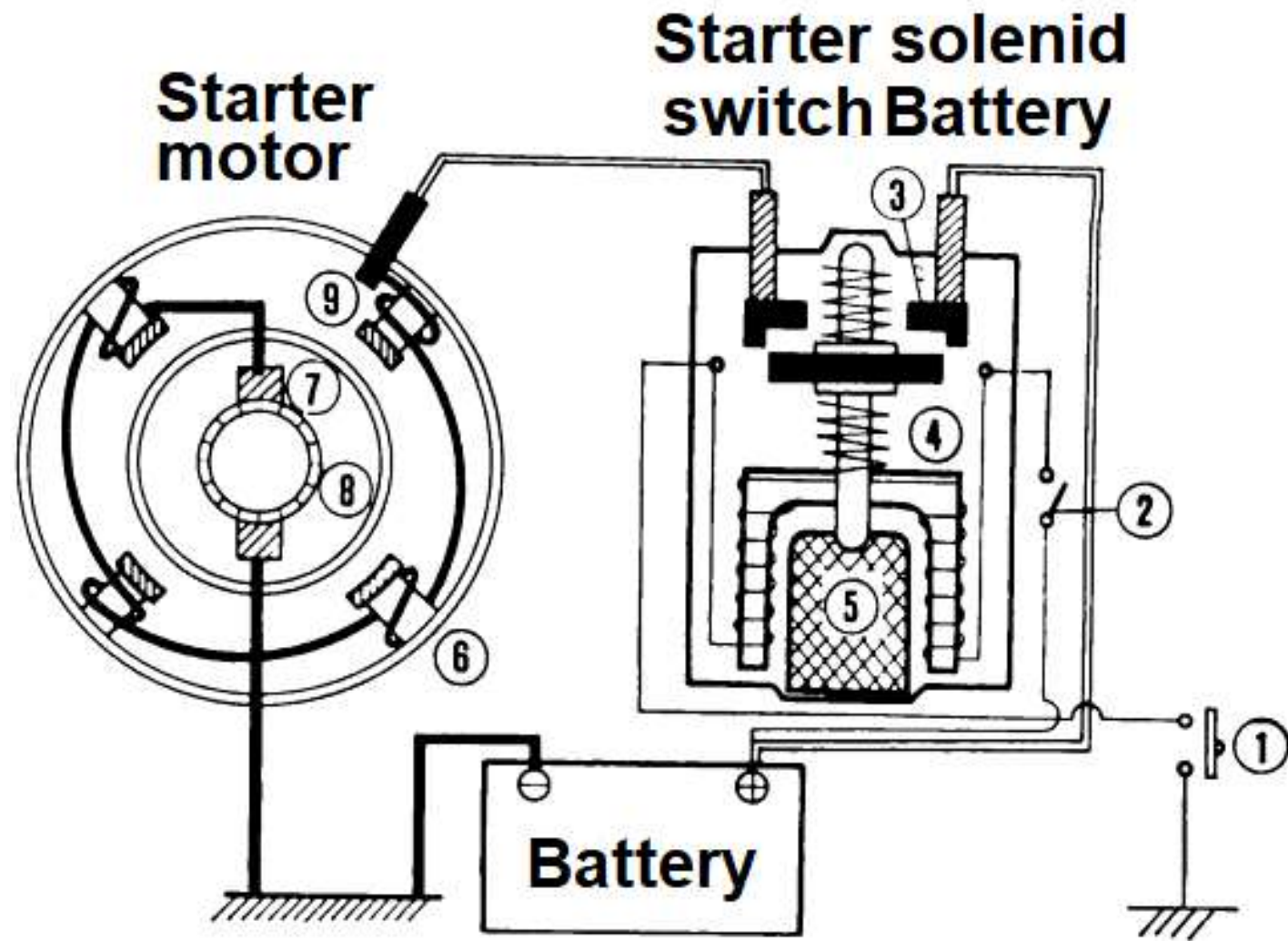
- **The digitally controlled transistorized ignition system** is a type of transistorized point less ignition (TPI), In this type of system, a transistor and a microcomputer are used to perform the trigger switching function.



Starter System in Motorcycle

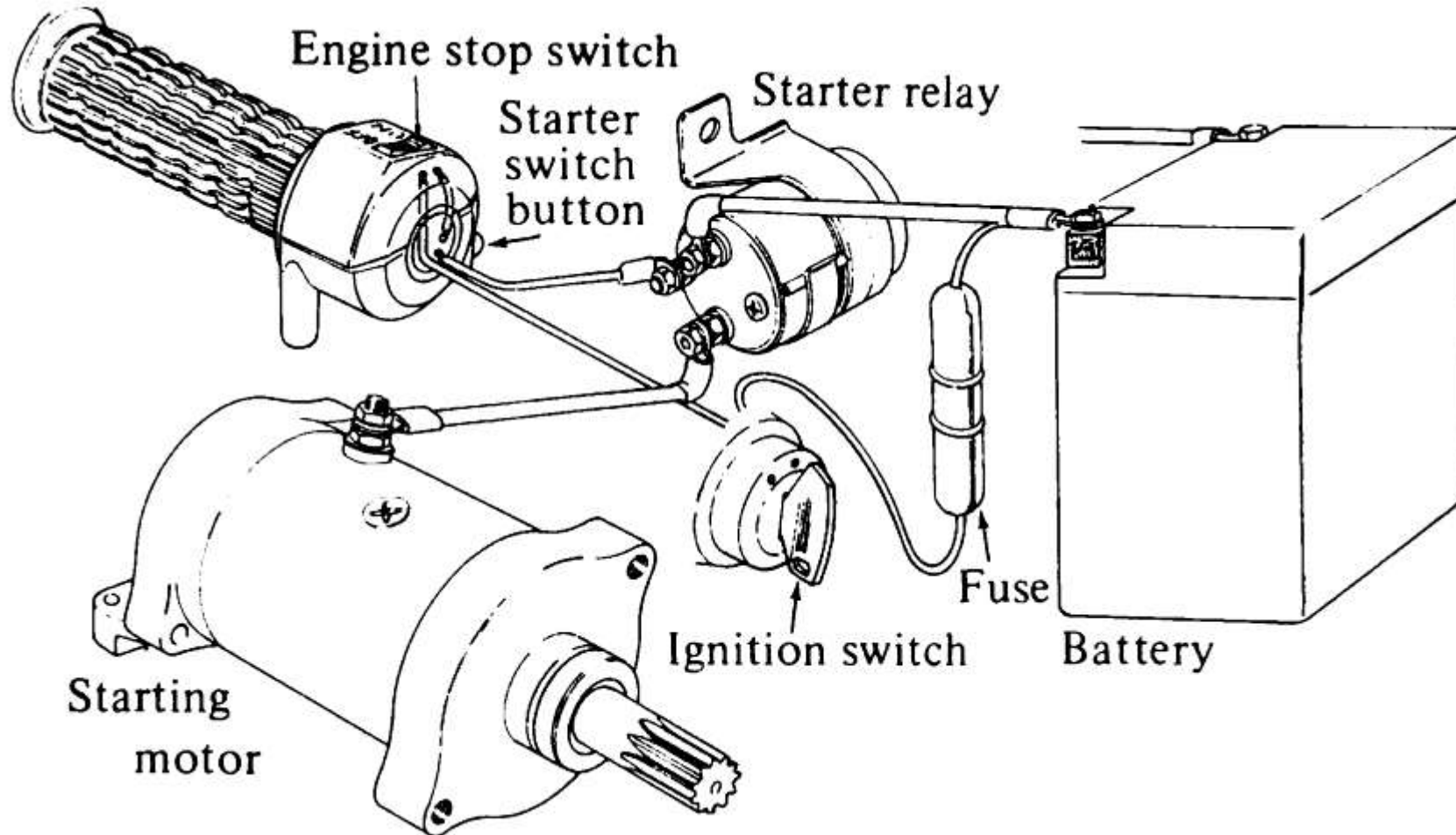
- All electric starting systems have two separate circuits: one for low current, and one for high current. Both circuits are connected to the battery.



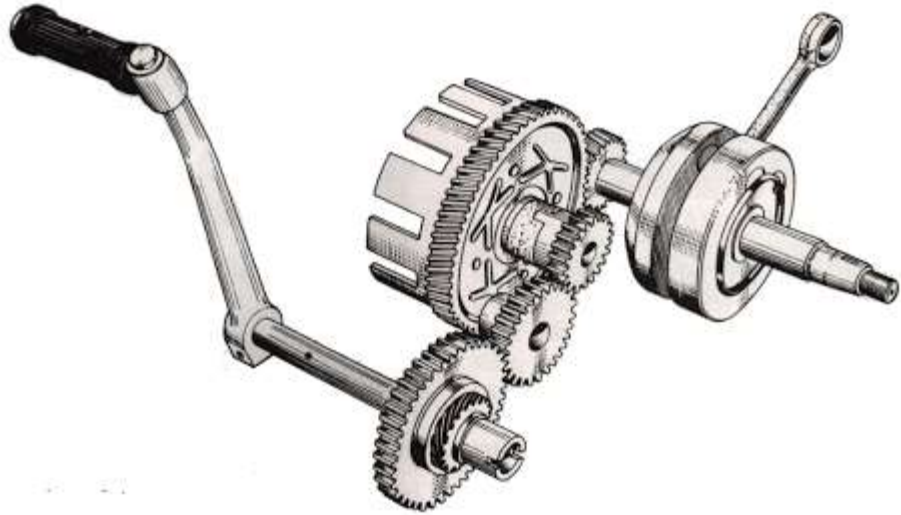


- 1- Starter button switch
- 2- Ignition switch
- 3- Contact unit
- 4- Excitation coil
- 5- Plunger
- 6- Pole
- 7- Bursh
- 8- Armature
- 9- Field coil

- The starter motor is a small electric motor. It's a small electrical motor that turns the crank shaft to produce the first injection and compression. When the spark plugs ignite the first compression the motor continues to run on the cycles of Injection, Compression , Ignition, Exhaust



- motorcycle kick start lever

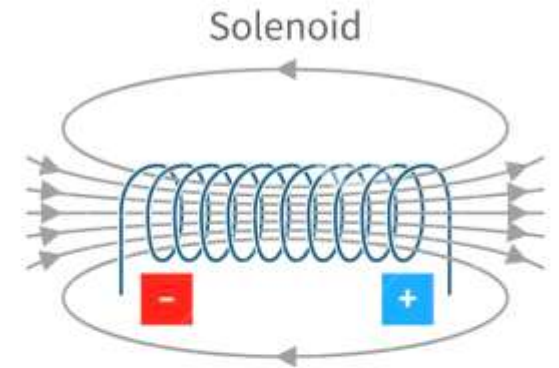


BASICS OF ELECTROMAGNETISM

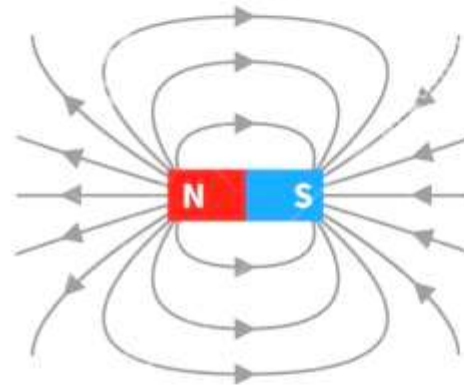
- **Magnetism** is the force exerted by magnets when they attract or repel each other. Magnetism is caused by the motion of electric charges. Every substance is made up of tiny units called atoms. Each atom has electrons, particles that carry electric charges

MAGNETIC FIELD

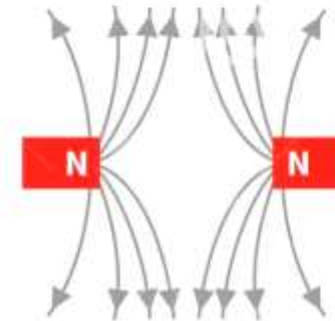
Is a force field that is created by moving electric charges and magnetic dipoles, and exerts a force on other nearby moving charges and magnetic dipoles



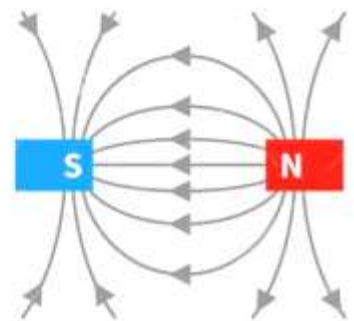
Bar magnet



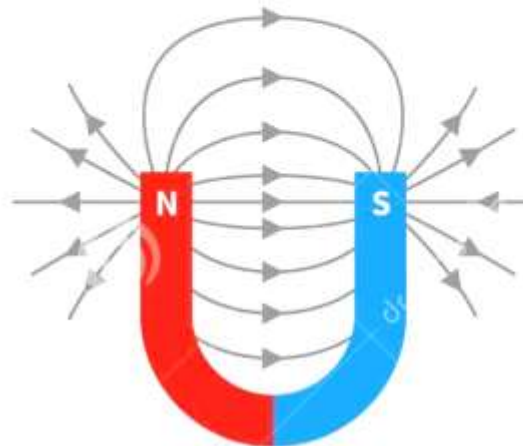
Unlike poles attract



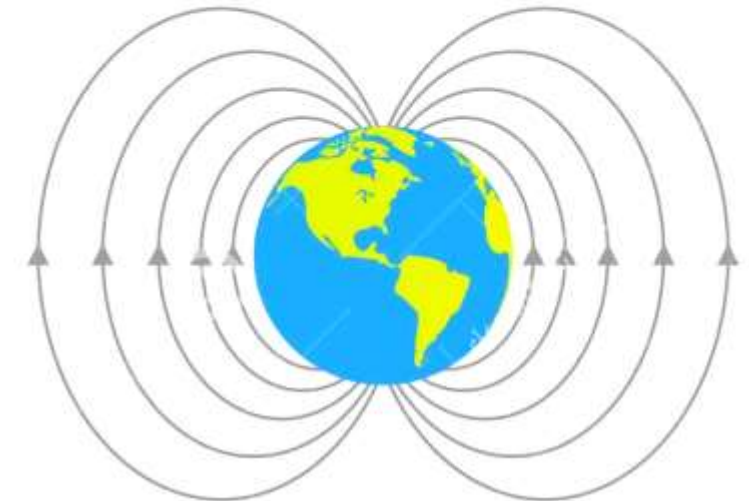
Like poles repel

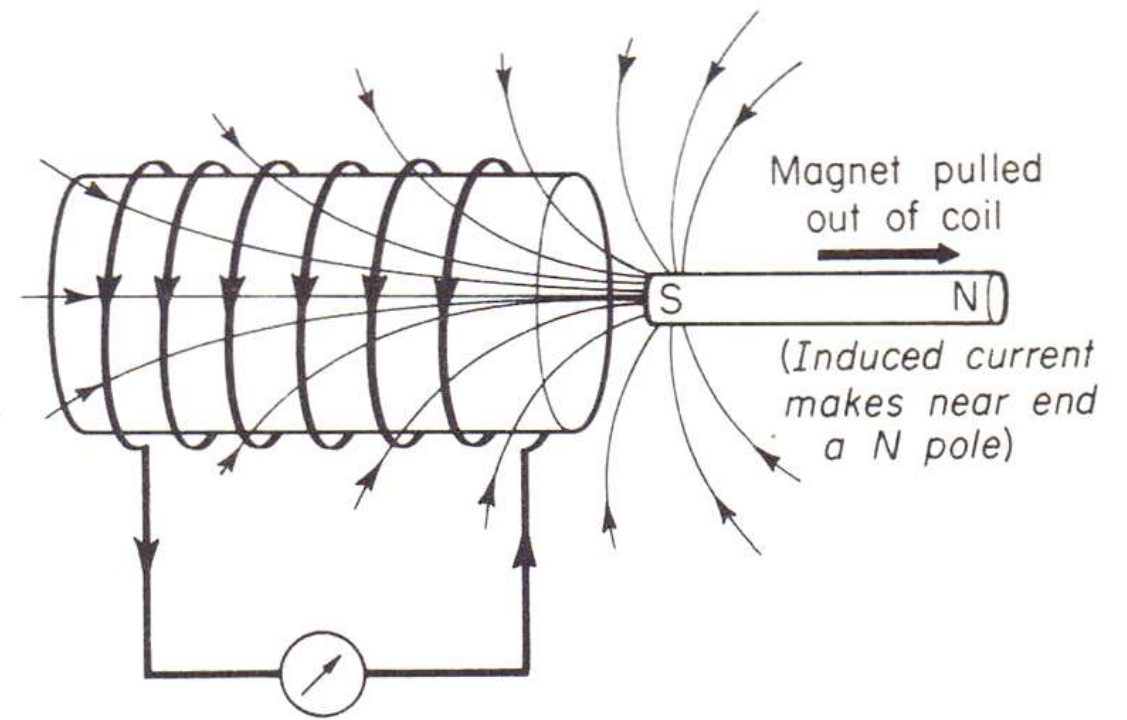
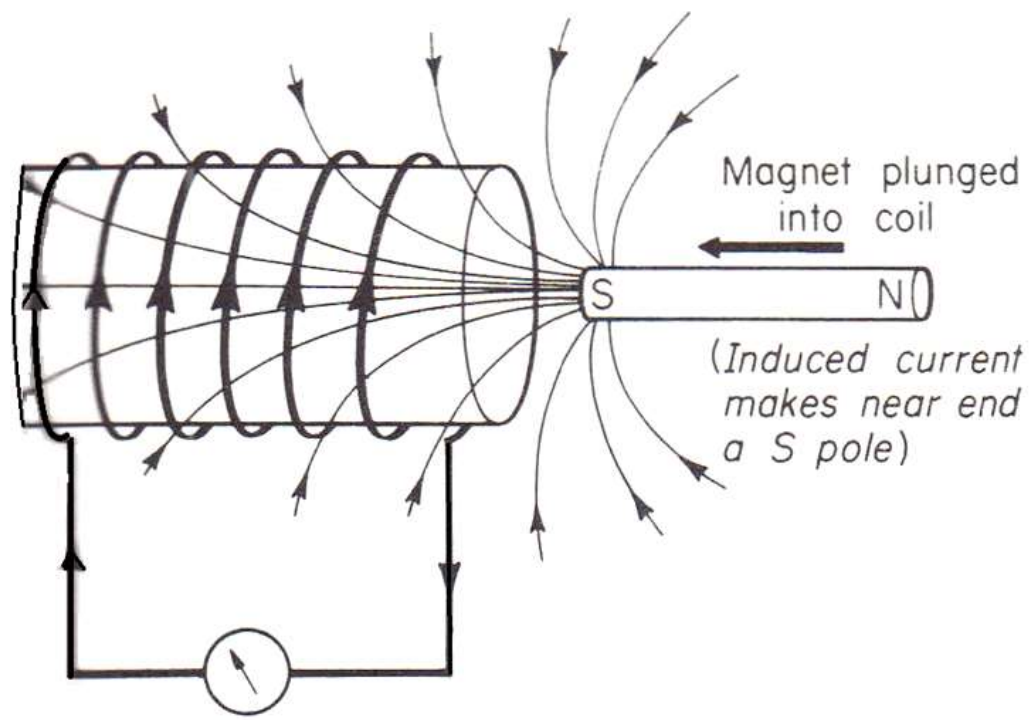


Horseshoe magnet



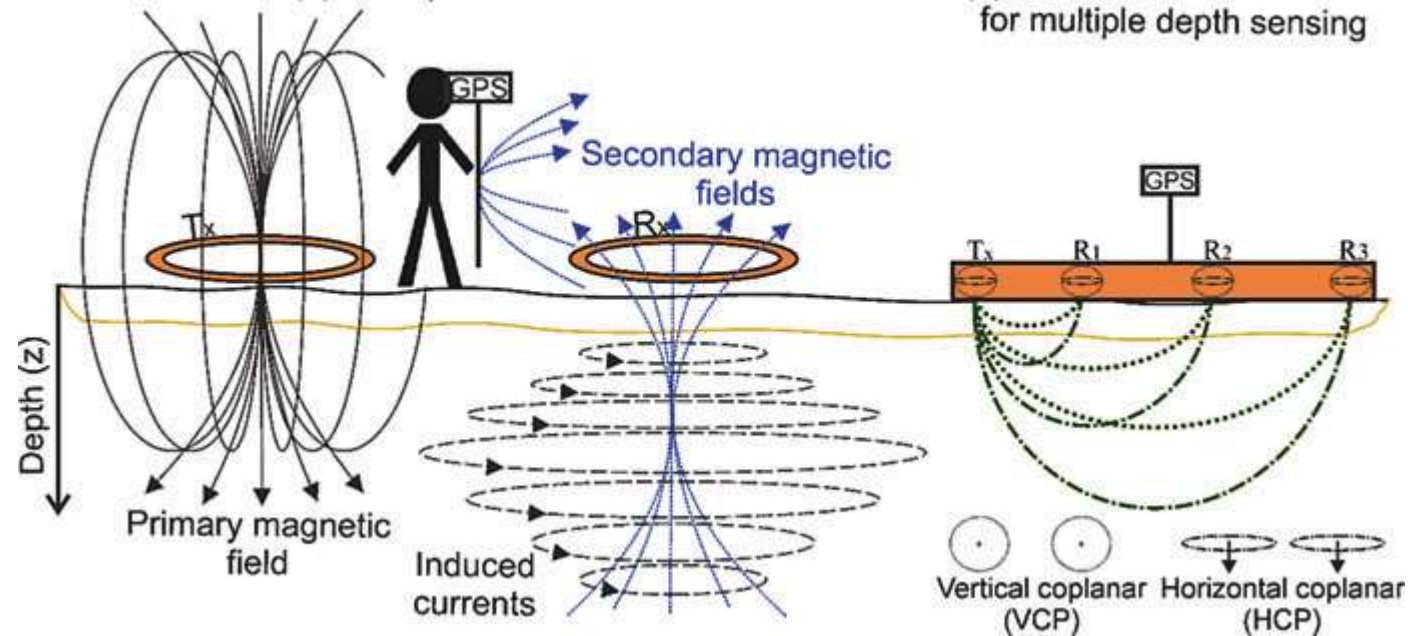
Earth's magnetic field



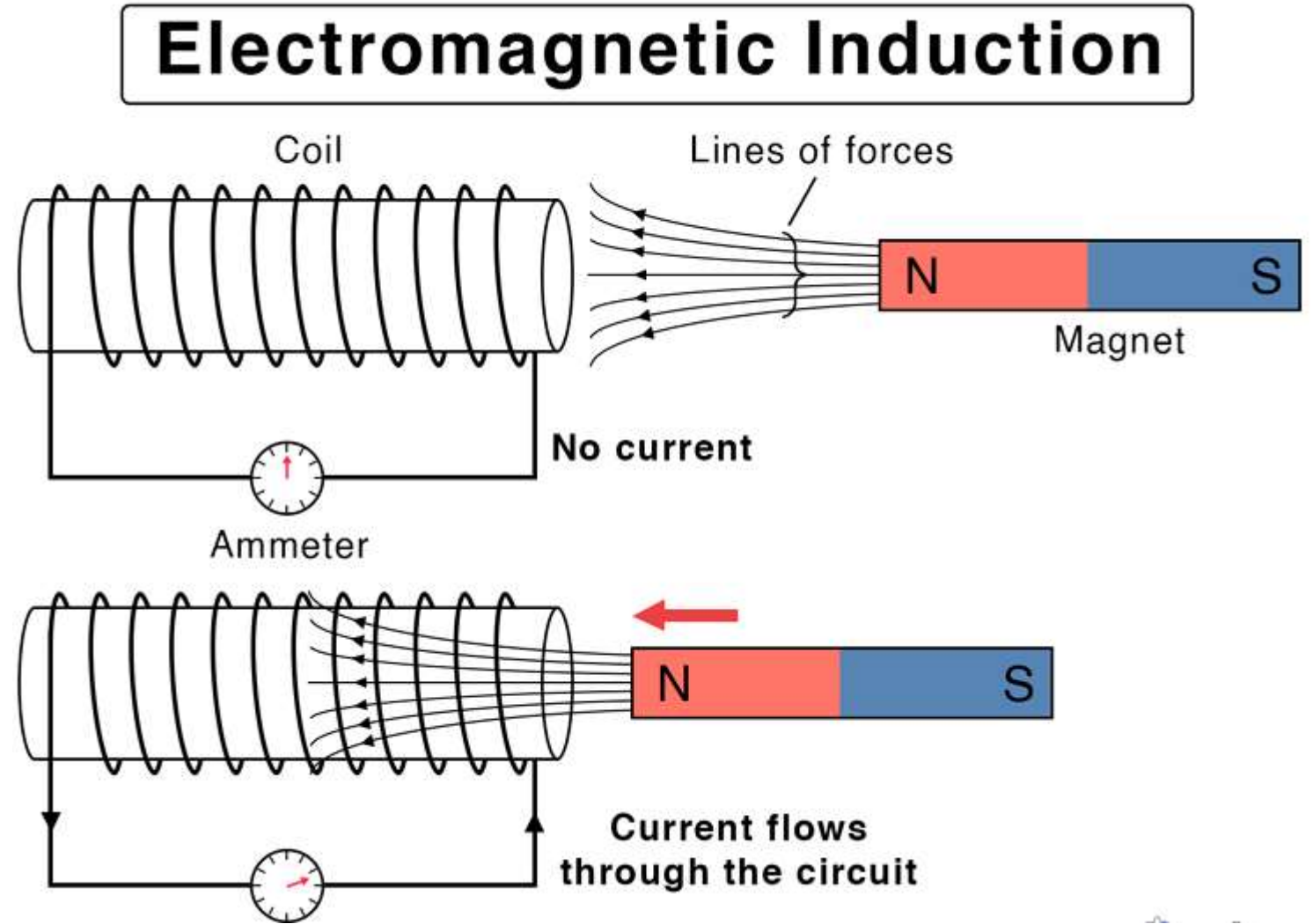


(a) Principle of EMI

(b) Multi-coil EMI instrument for multiple depth sensing

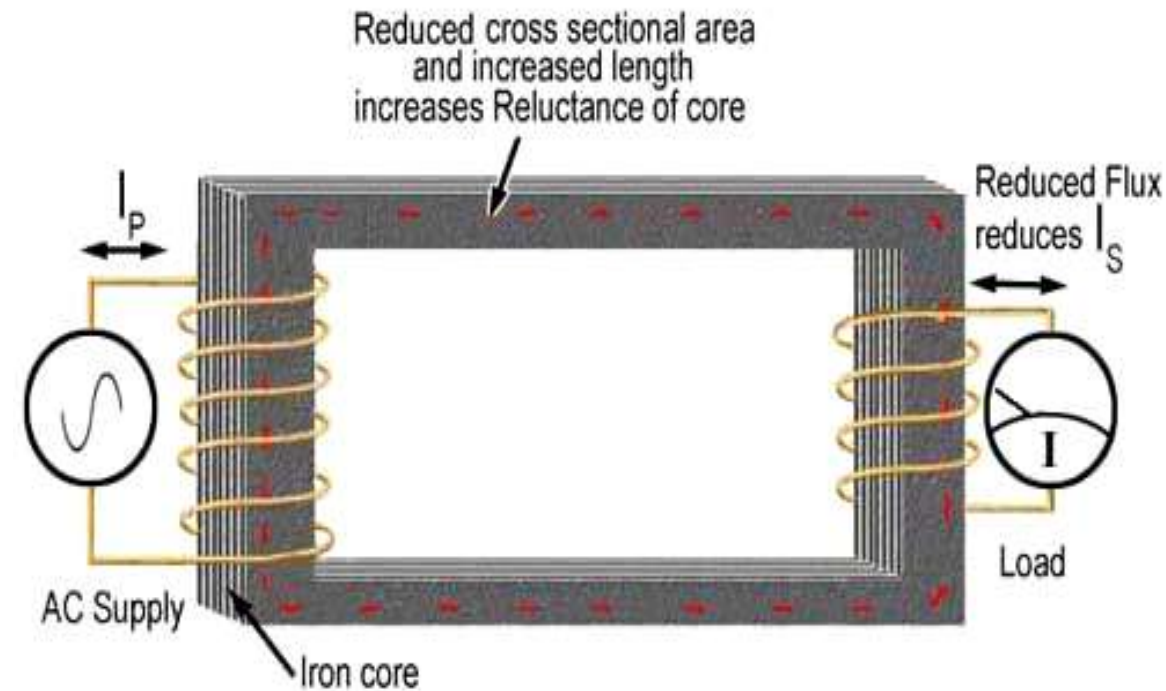


- **Flux Density** The more flux lines, the stronger the magnetic field at that point. Increasing current will increase flux density
- **Coils** Looping a wire into a coil concentrates the lines of flux inside the coil. The resulting magnetic field is the sum of the single-loop magnetic fields



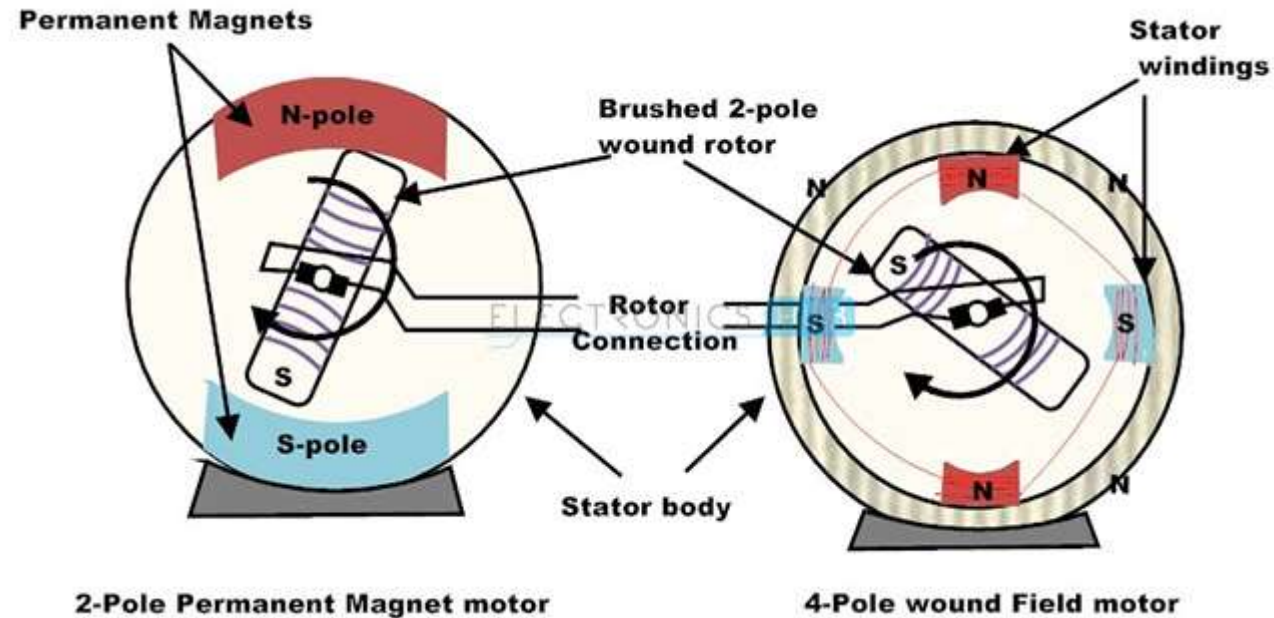
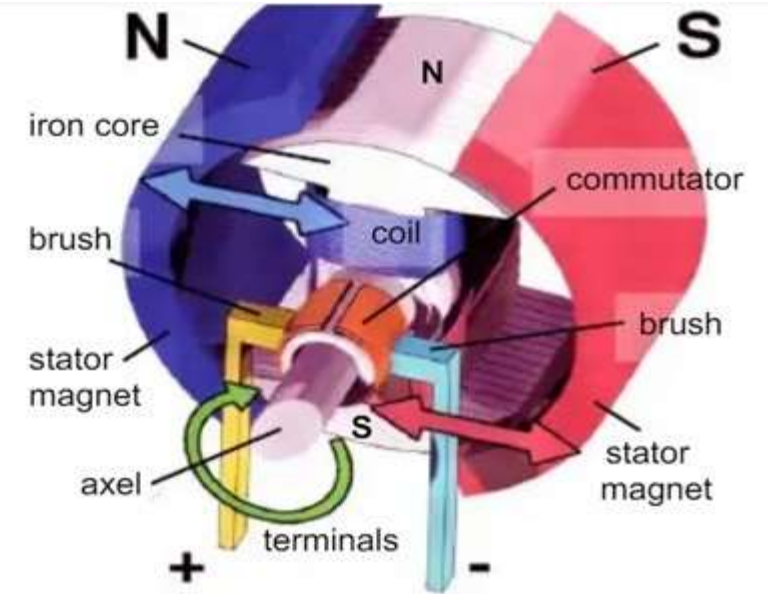
Magnetic Circuits and Reluctance

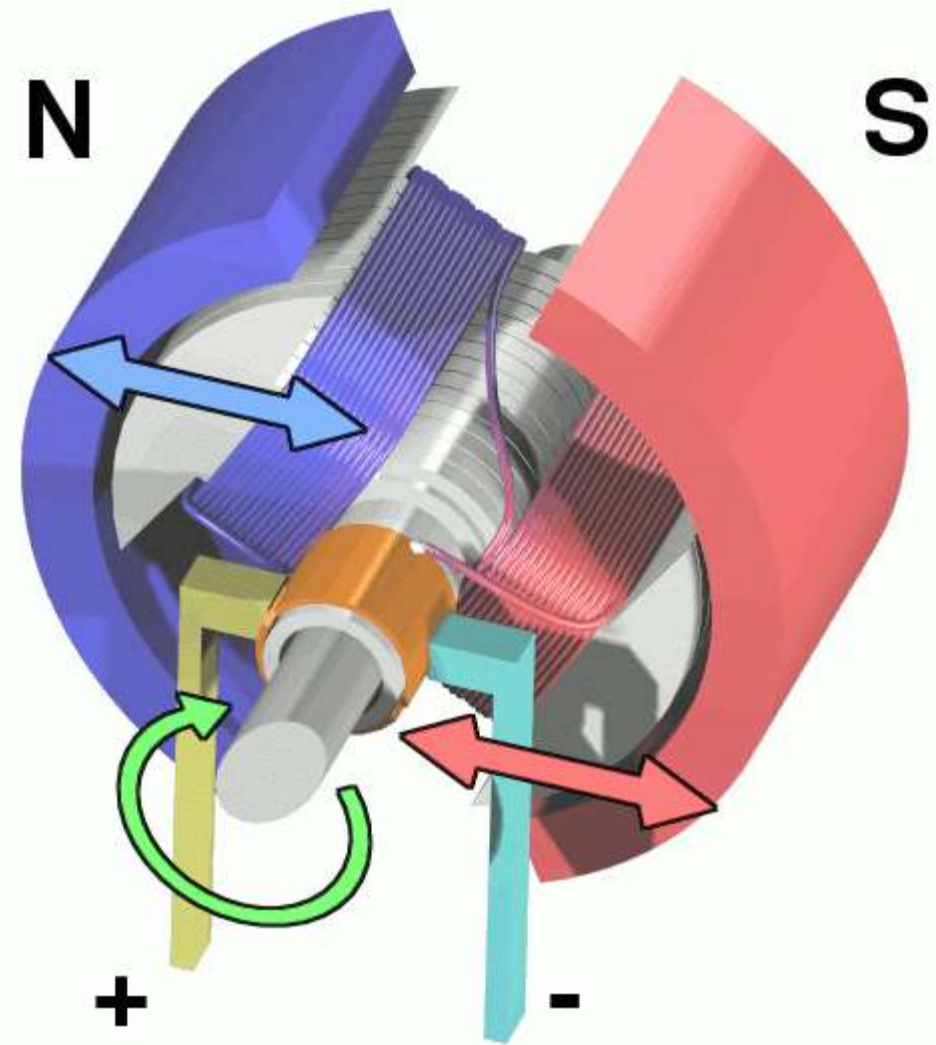
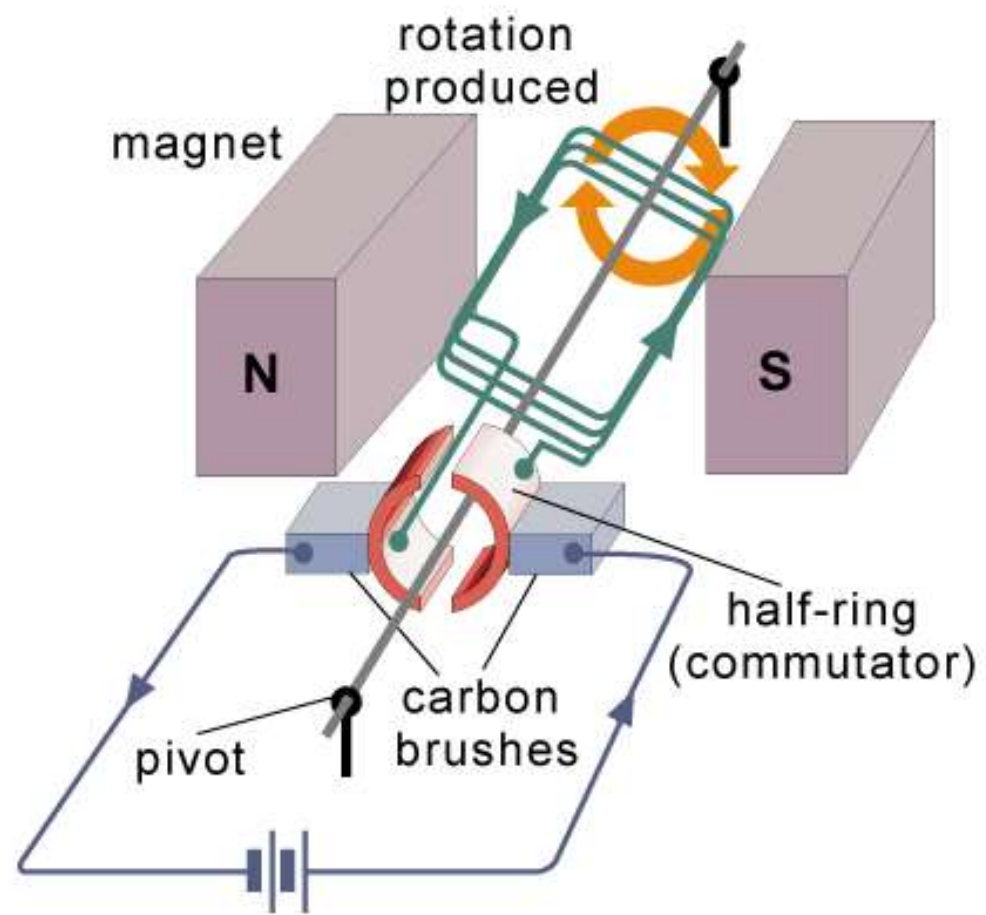
- Magnetic reluctance (also known as reluctance, magnetic resistance or a magnetic insulator) is defined as the opposition offered by a magnetic circuit to the production of magnetic flux. It is the property of the material that opposes the creation of magnetic flux in a magnetic circuit.
- The magnetic polarity of the coil depends on the direction of current flow through the loop
- Field strength increases if current through the coil increases.
- Field strength increases if the number of coil turns increases. If reluctance increases, field strength decreases.

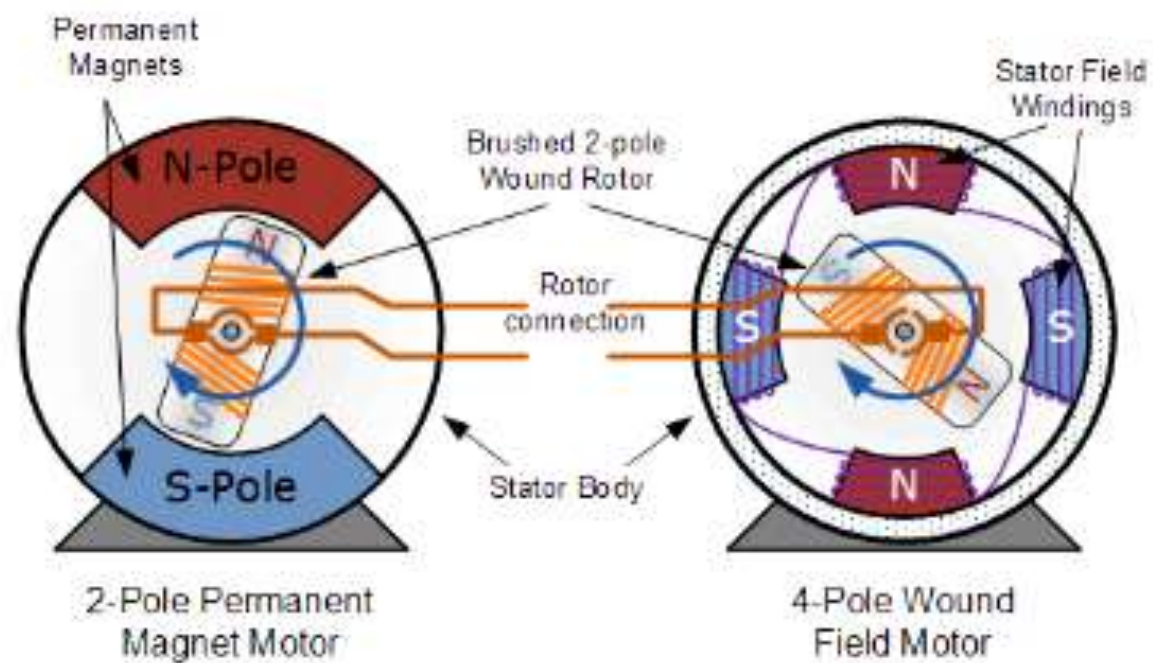
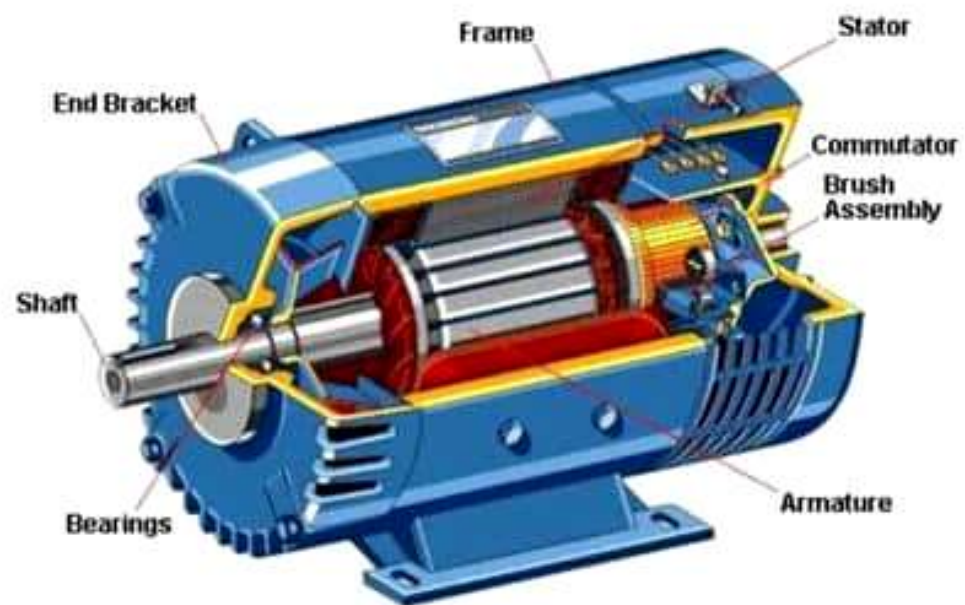


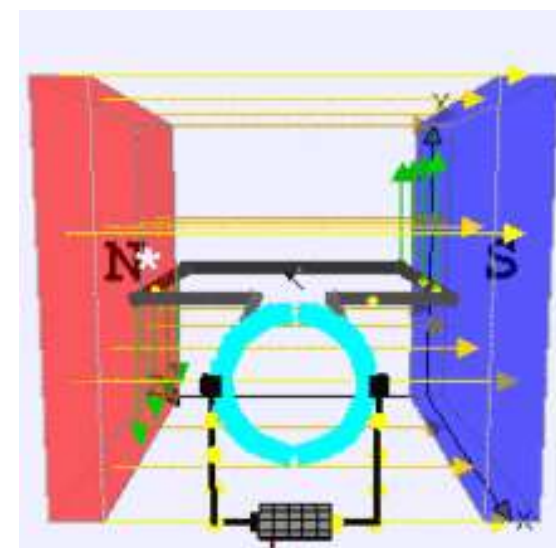
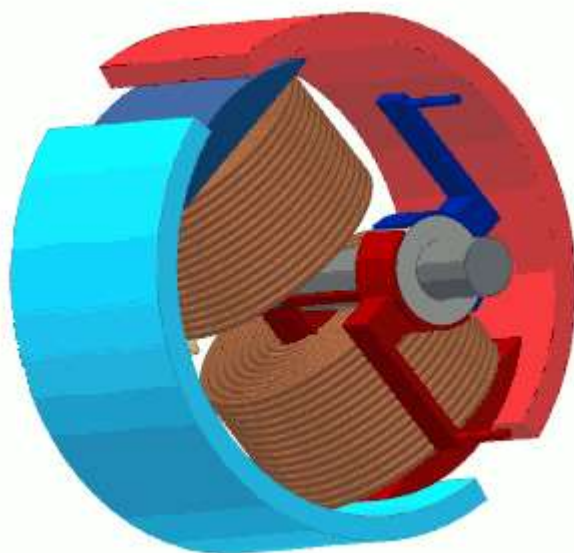
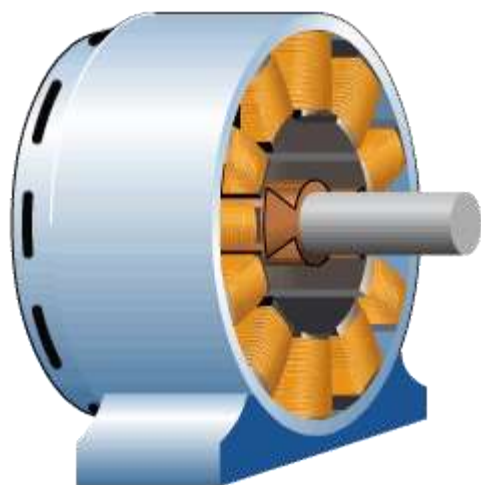
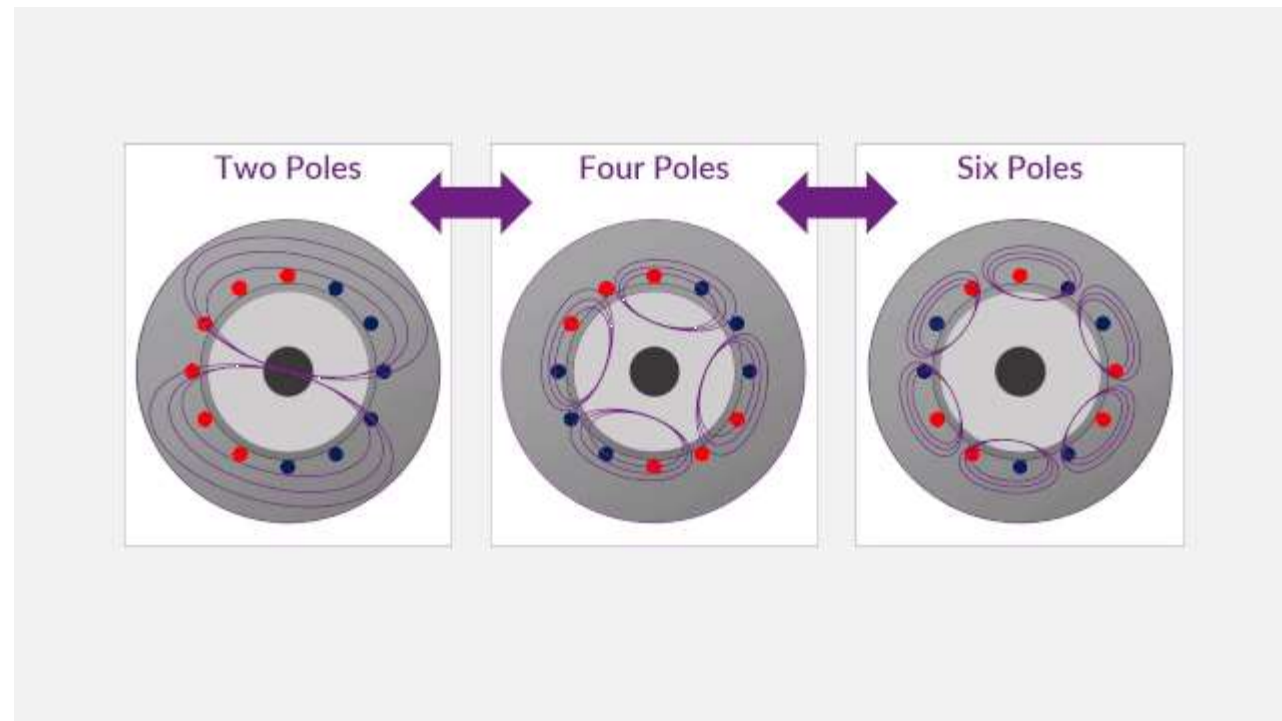
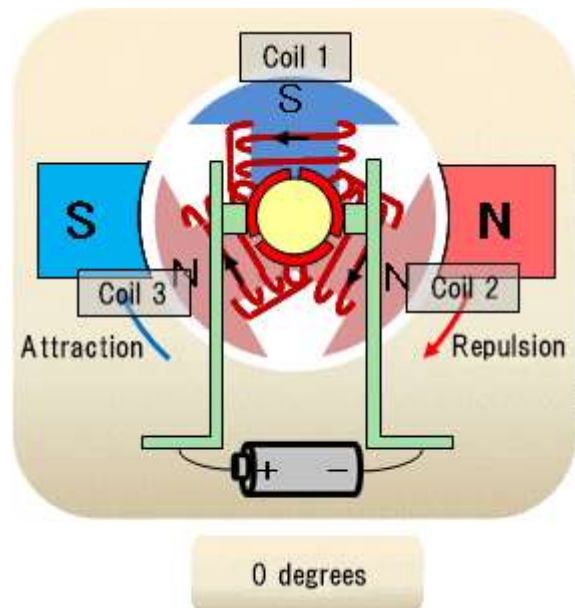
Electric Motors

- An **electric motor** is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding to generate force in the form of torque applied on the motor's shaft. An electric generator is mechanically identical to an electric motor, but operates with a reversed flow of power, converting mechanical energy into electrical energy.







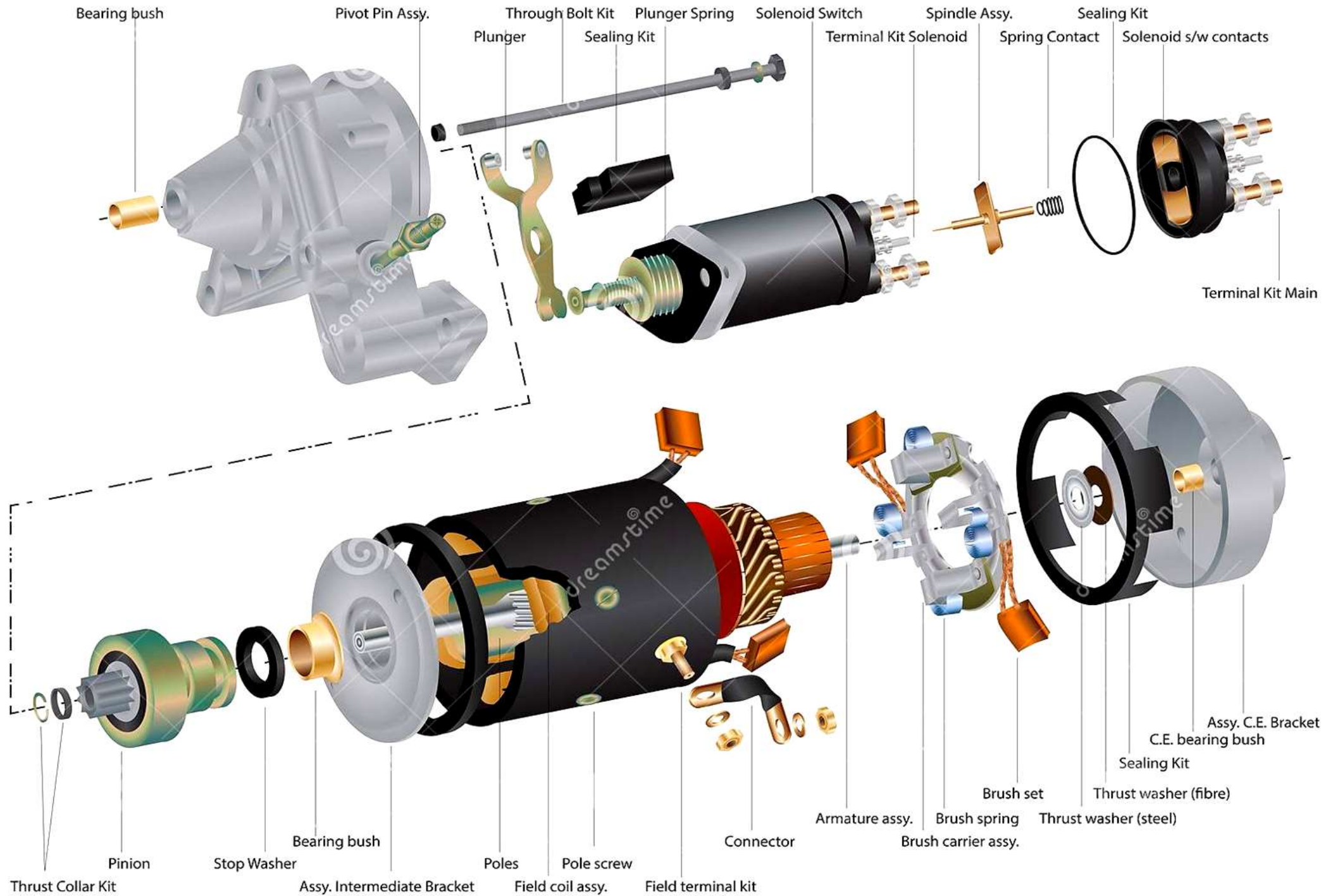


Starter Motor: A starter is a device used to rotate an internal-combustion engine so as to initiate the engine's operation under its own power.



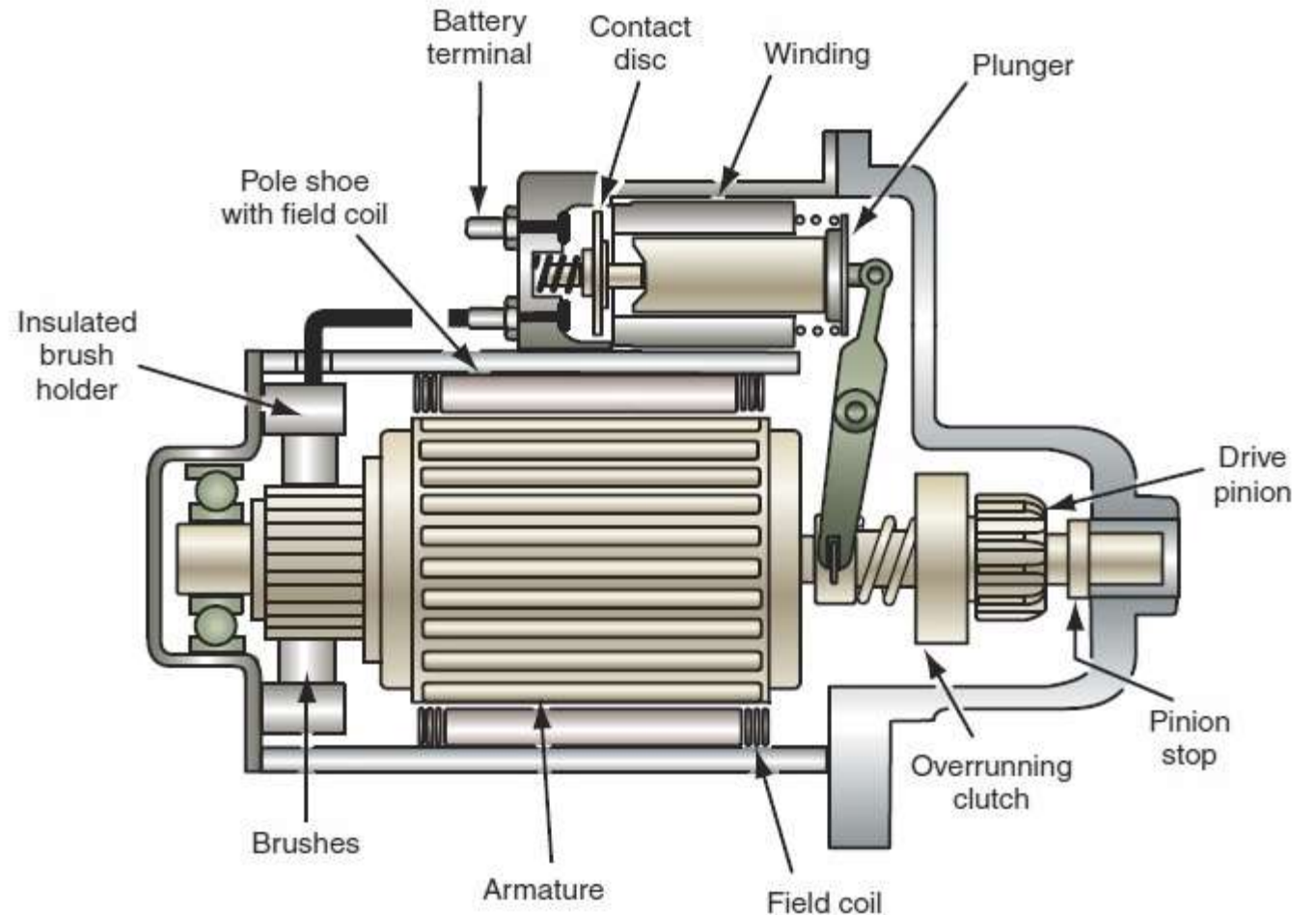
Starter Motor





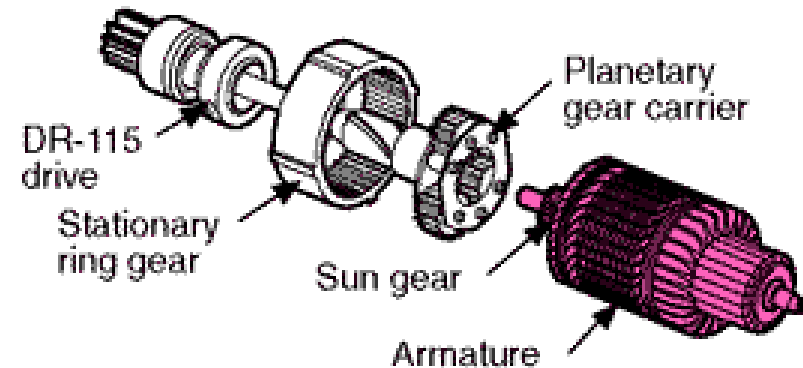
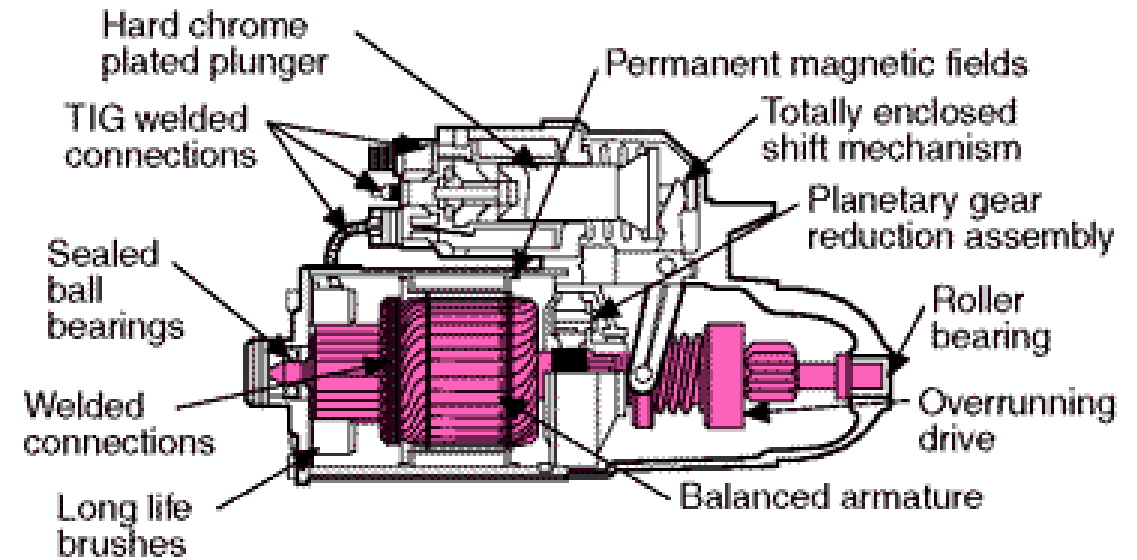
Operating Principles

- When the ignition key or button is pressed, the transmission should be in park or neutral state. The battery voltage goes through the starter control circuit to activate the solenoid. The starter motor is powered by the solenoid, which helps to push the starter gear forward to mesh with the engine flywheel. This flywheel is mounted on the engine crankshaft, so as the starter motor spins it turns the flywheel so as the crankshaft. As soon as the engine starts, the system disengages from the flywheel.



Permanent Magnet Motors

- A permanent magnet motor is a type of electric motor that uses permanent magnets in addition to windings on its field, rather than windings only.

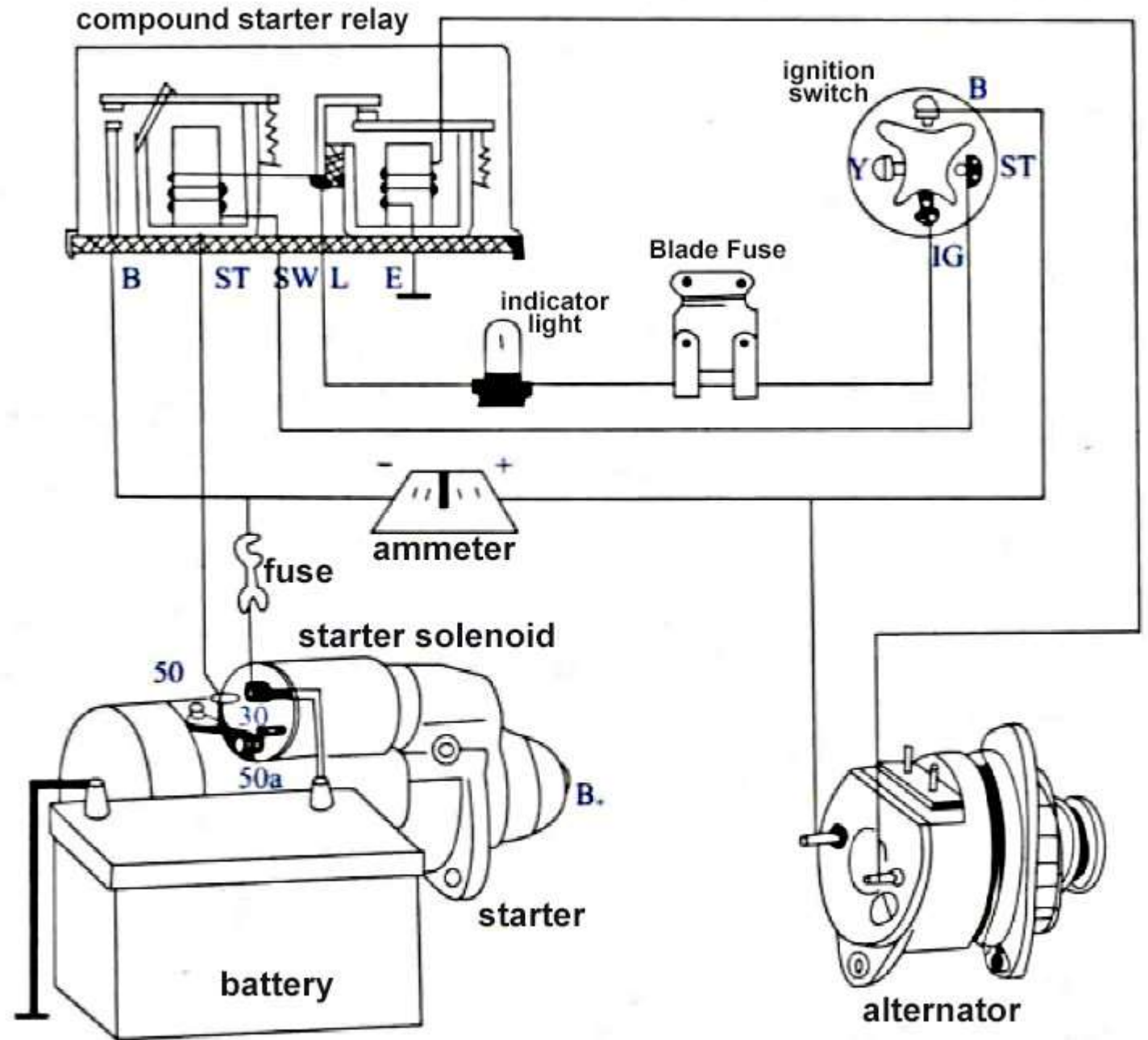


Counter EMF

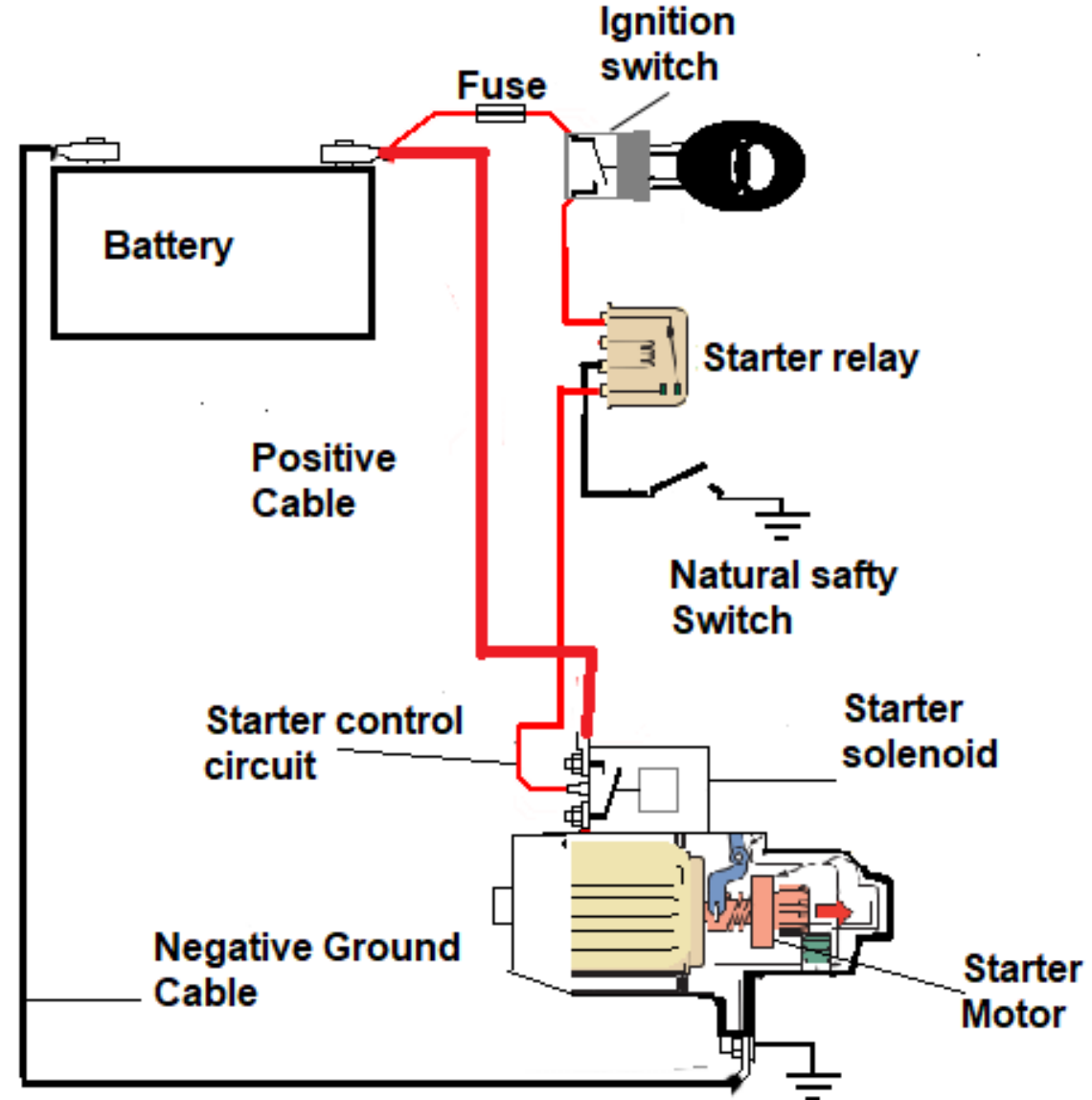
- Back EMF (counter EMF, CEMF), also known as back electromotive force (back EMF), is the electromotive force (voltage) that opposes the change in current which induced it. CEMF is the EMF caused by magnetic induction

STARTING SYSTEM

- The starting system includes the battery, starter motor, solenoid, ignition switch and in some cases, a starter relay. An inhibitor or a neutral safety switch is included in the starting system circuit to prevent the vehicle from being started while in gear. When the ignition key is turned to the start position, current flows and energizes the starter's solenoid coil. The energized coil becomes an electromagnet which pulls the plunger into the coil. The plunger closes a set of contacts which allow high current to reach the starter motor.

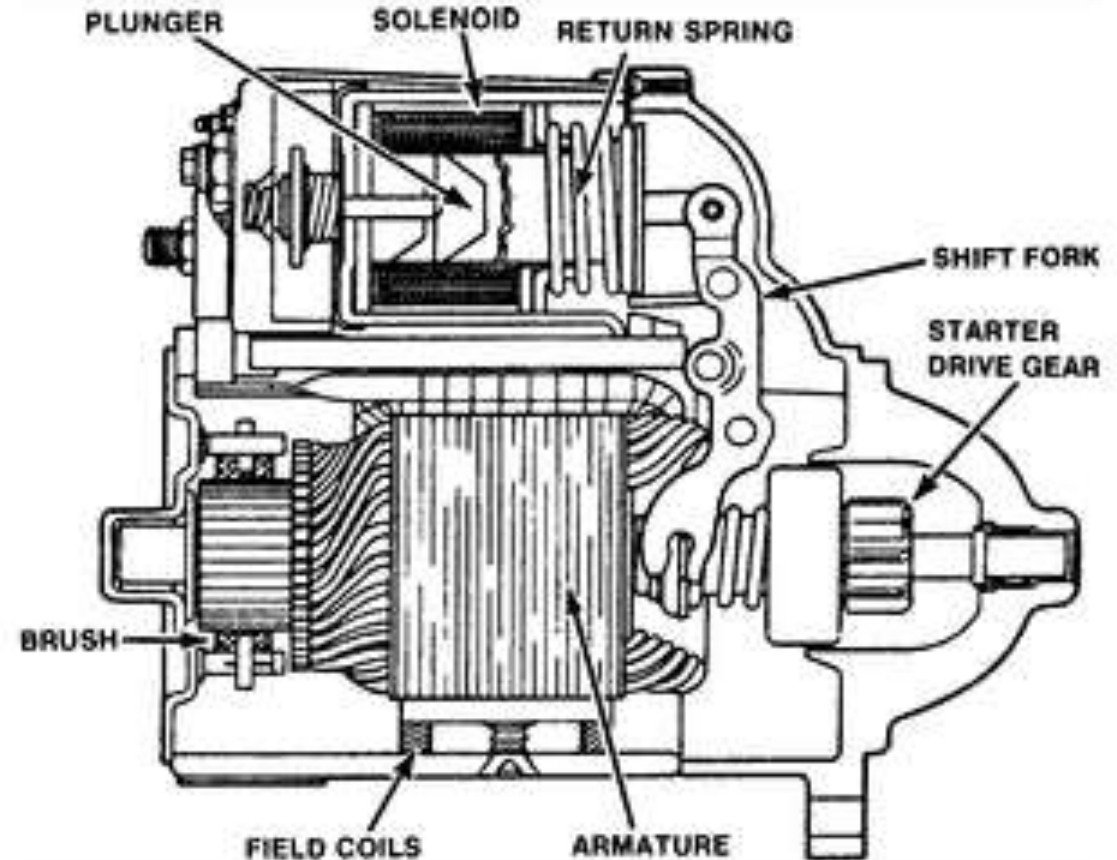


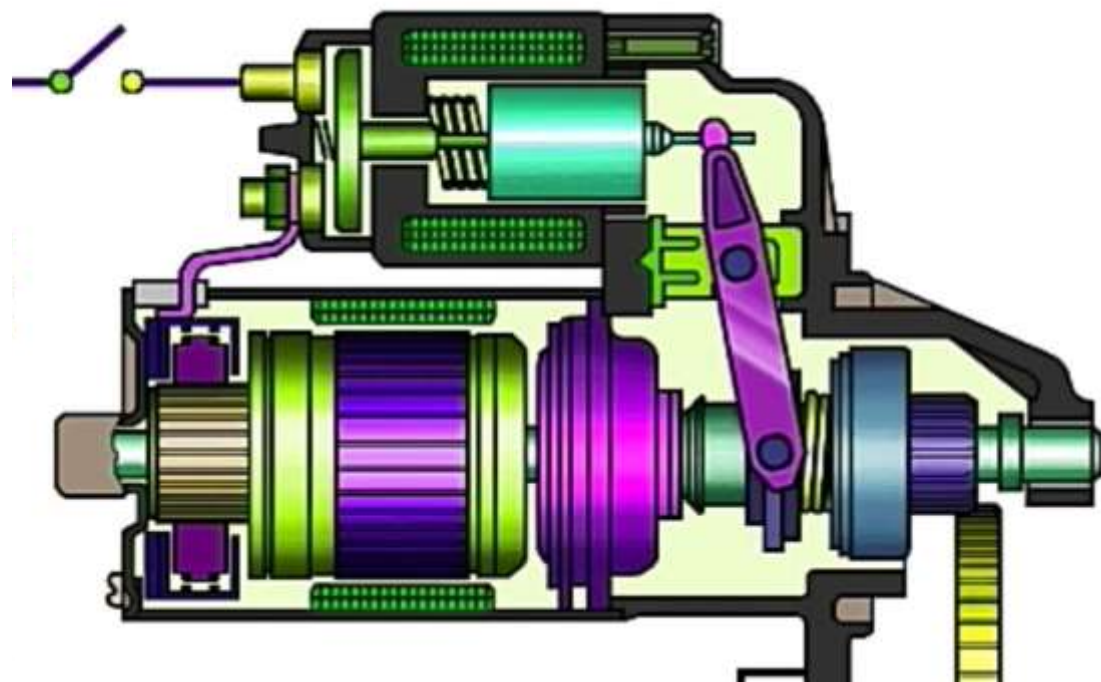
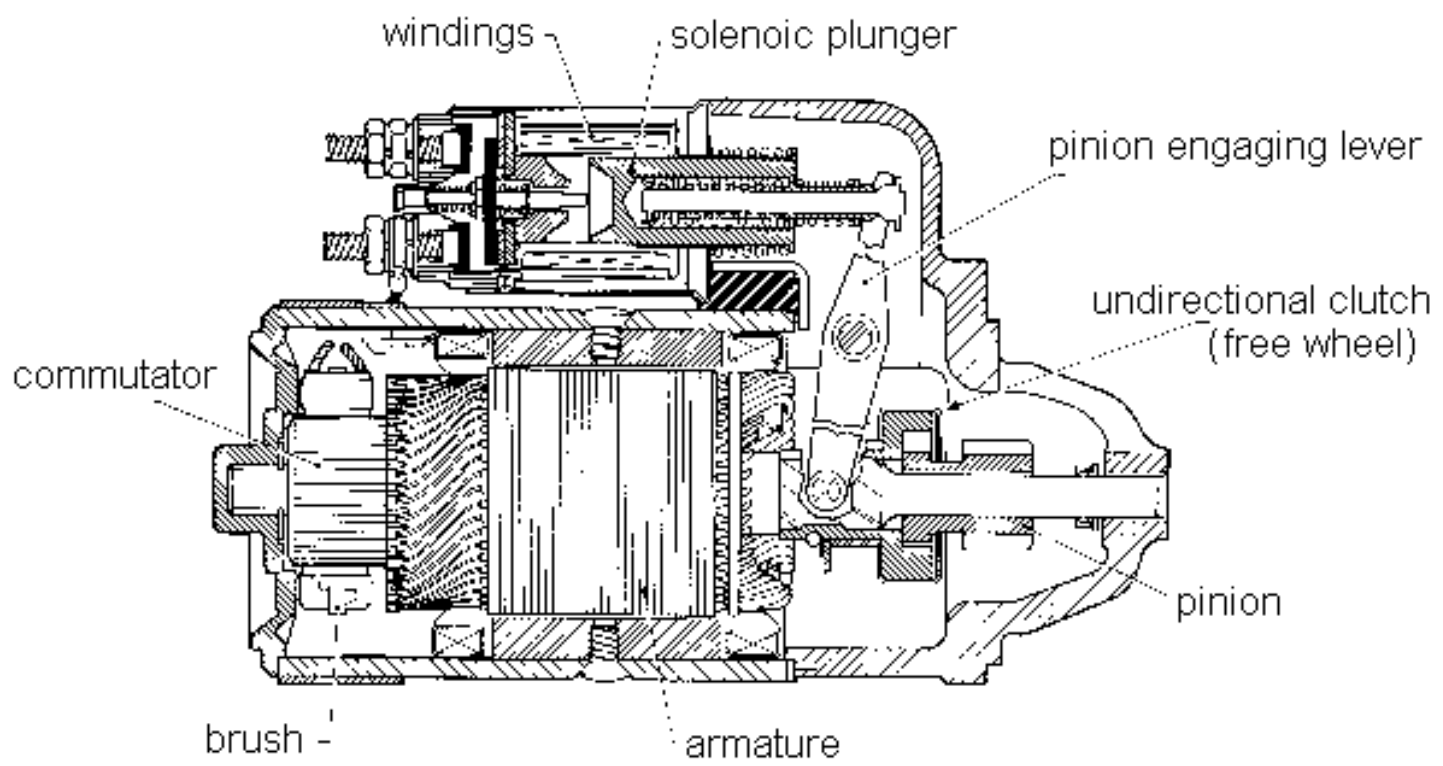
- Battery and Cables

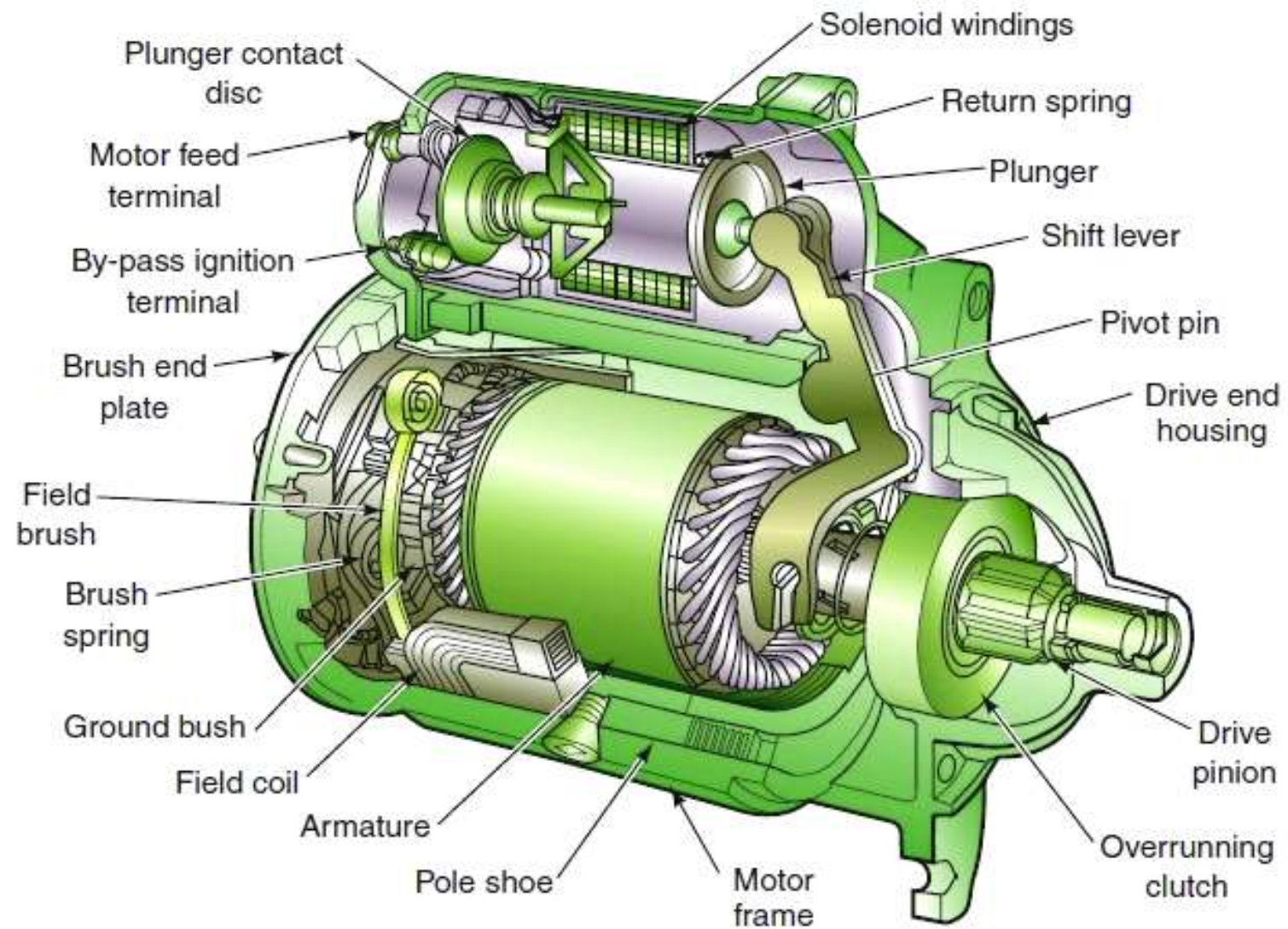


Magnetic Switches

- A solenoid is a device comprised of a coil of wire, the housing and a moveable plunger (armature). When an electrical current is introduced, a magnetic field forms around the coil which draws the plunger in. More simply, a solenoid converts electrical energy into mechanical work.

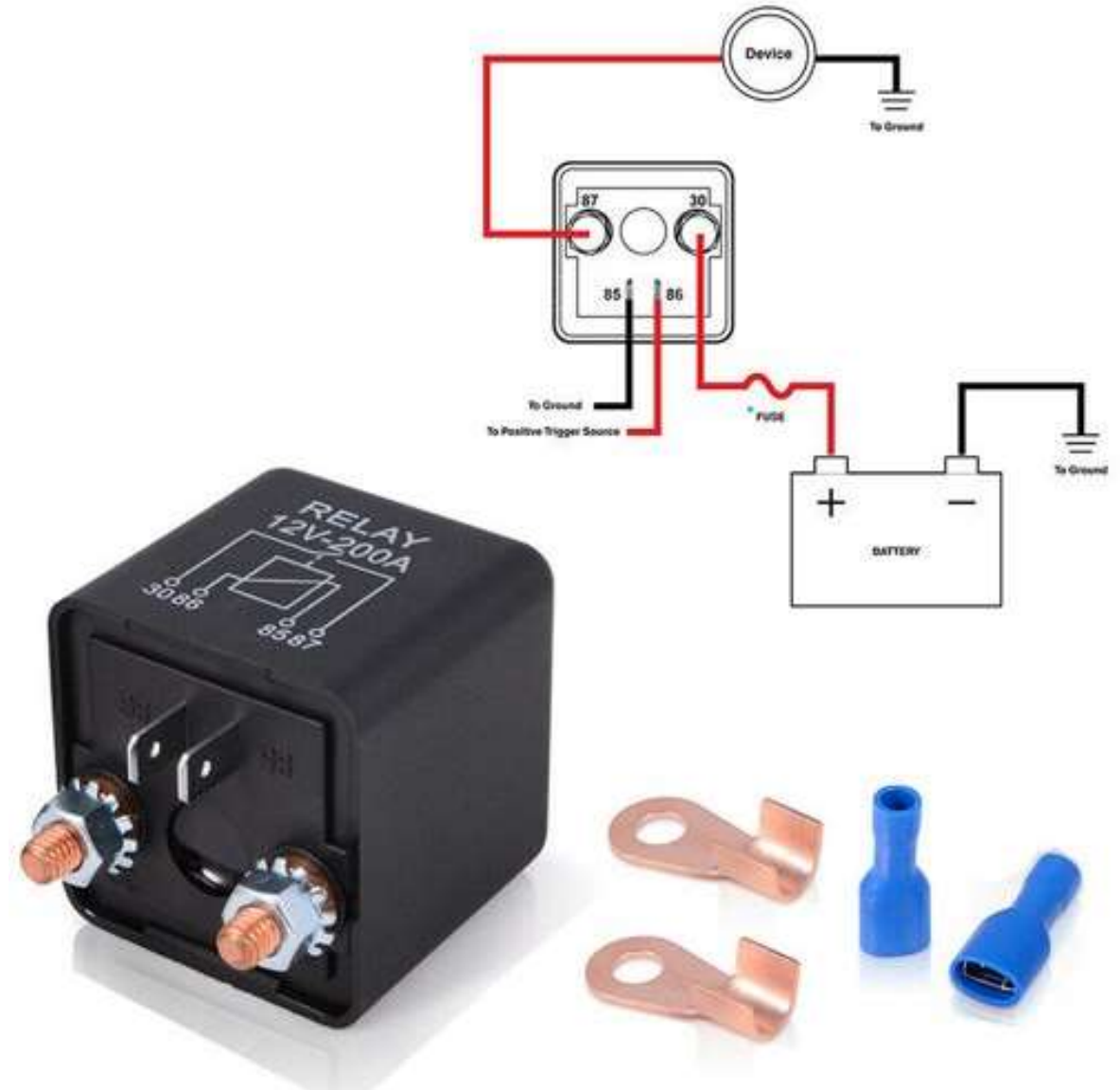






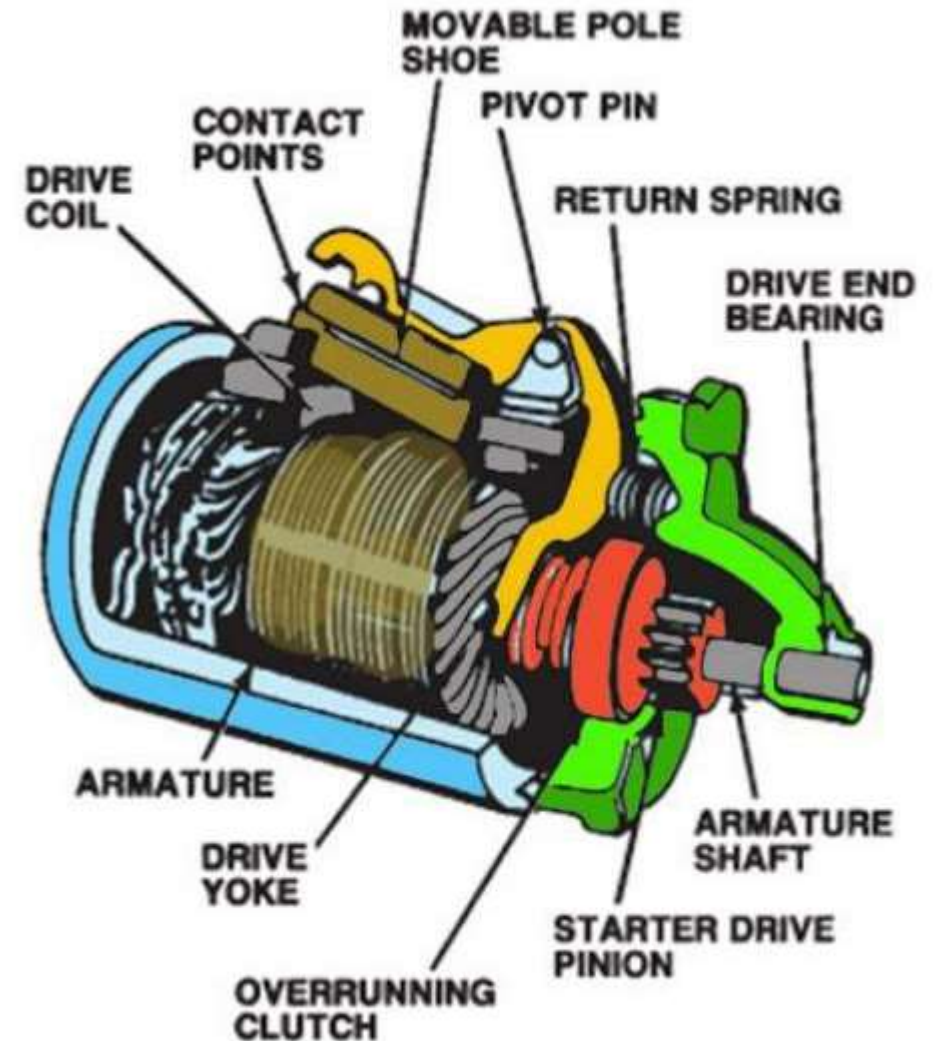
- **Starter Relay**

They are used as an electrical relay or switch. When current from the ignition switch arrives at the relay, a strong magnetic field is generated in the relay's coil. This magnetic force pulls the plunger contact disc up against the battery terminal and the starter terminal of the relay, allowing full current flow to the starter motor



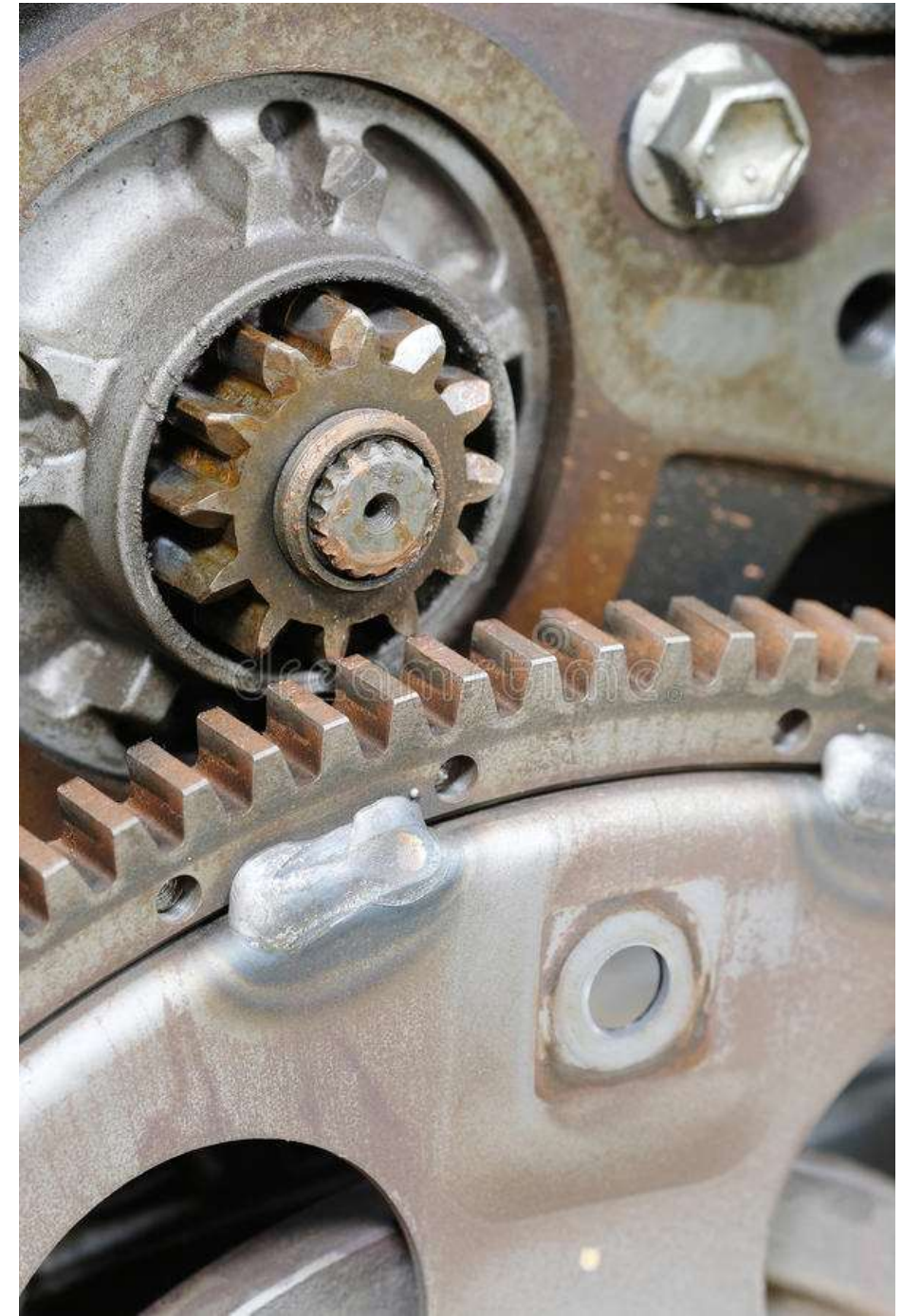
Positive Engagement Movable Pole Shoe Drive

- by a starter relay mounted close to the battery. When you crank the motor, the circuit in the relay is then closed, and current flows through the drive coil. The drive coil creates an electromagnetic field that attracts a moveable pole shoe.



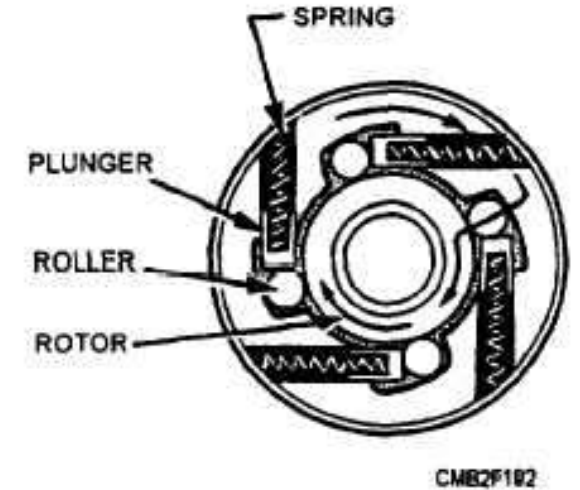
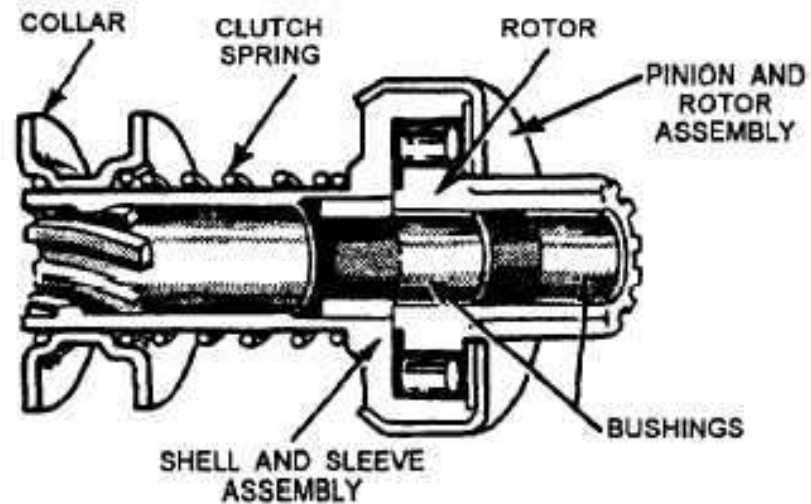
Starter Drives

- The pinion gear is a small gear on the armature shaft that engages the ring gear on the flywheel. Most starter pinion gears are made as part of a pinion drive mechanism. The pinion drive mechanism slides over one end of the starter armature shaft.

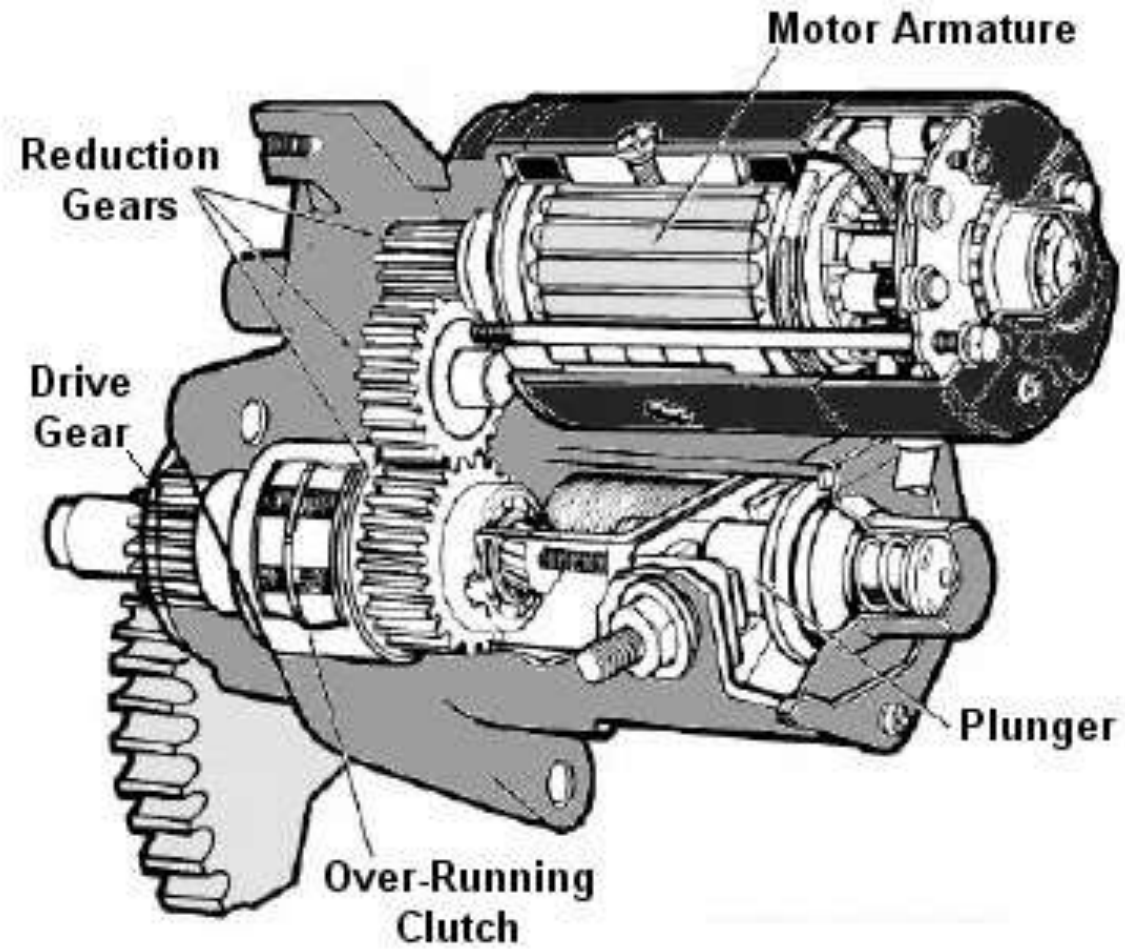


Overrunning Clutch

- An overrunning clutch is a device designed to mechanically separate the driveshaft from the driven shaft when the driveshaft behaves in a certain way. The overrunning clutch operates when the driveshaft or input rotates slower than the driven shaft or output. It also disengages when the driveshaft completely stops.



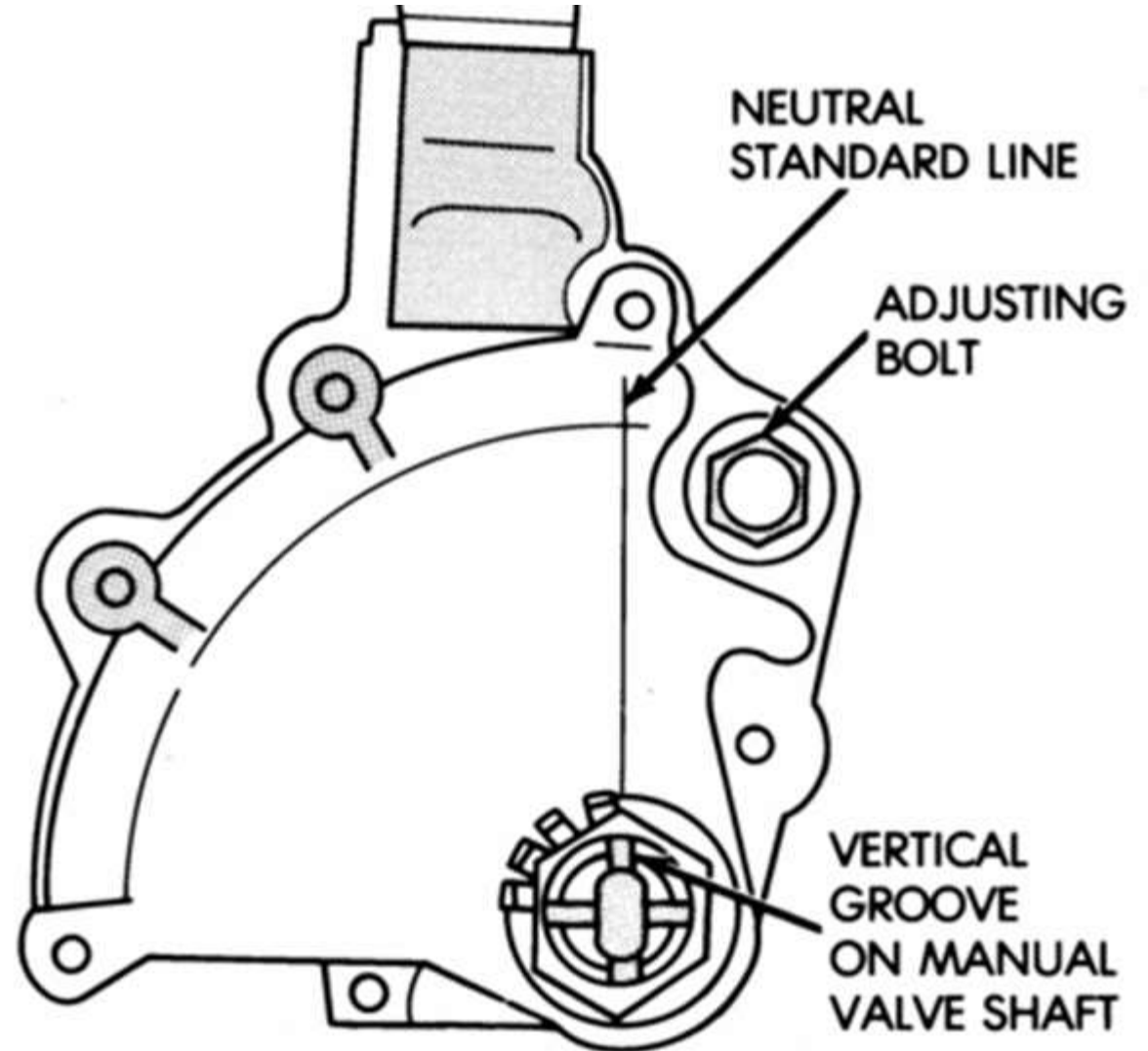
Gear Reduction Drive



CONTROL CIRCUIT

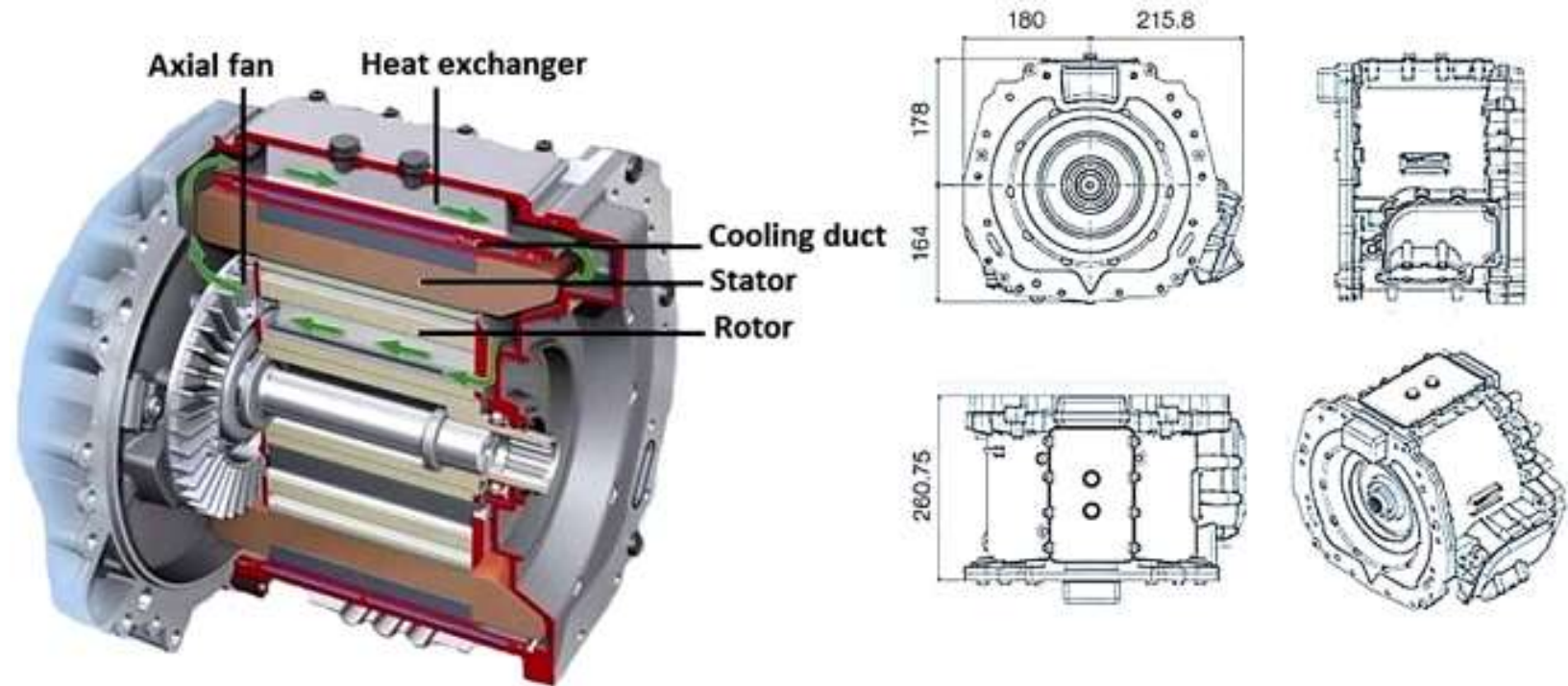
Starting Safety Switch

- the neutral safety switch (also known as the starting safety switch) is a switch, normally open, that keeps the starting system from operating while the transmission is in gear. The vehicle should only start when the shift selector is in Park or Neutral.

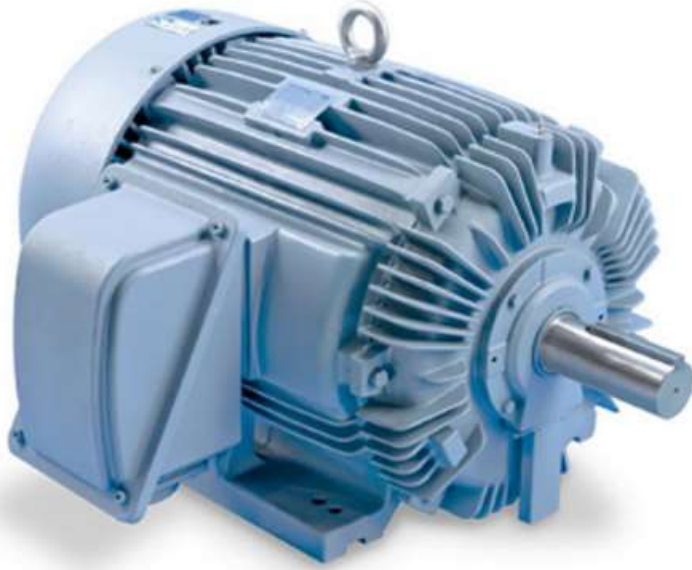


HIGH-VOLTAGE MOTORS

Traction Motors



AC Motor



**AC Motor doesn't use brushes
AC Motor has a longer life span
AC Motor is not costly
AC Motor can be a single phase or 3 phase**

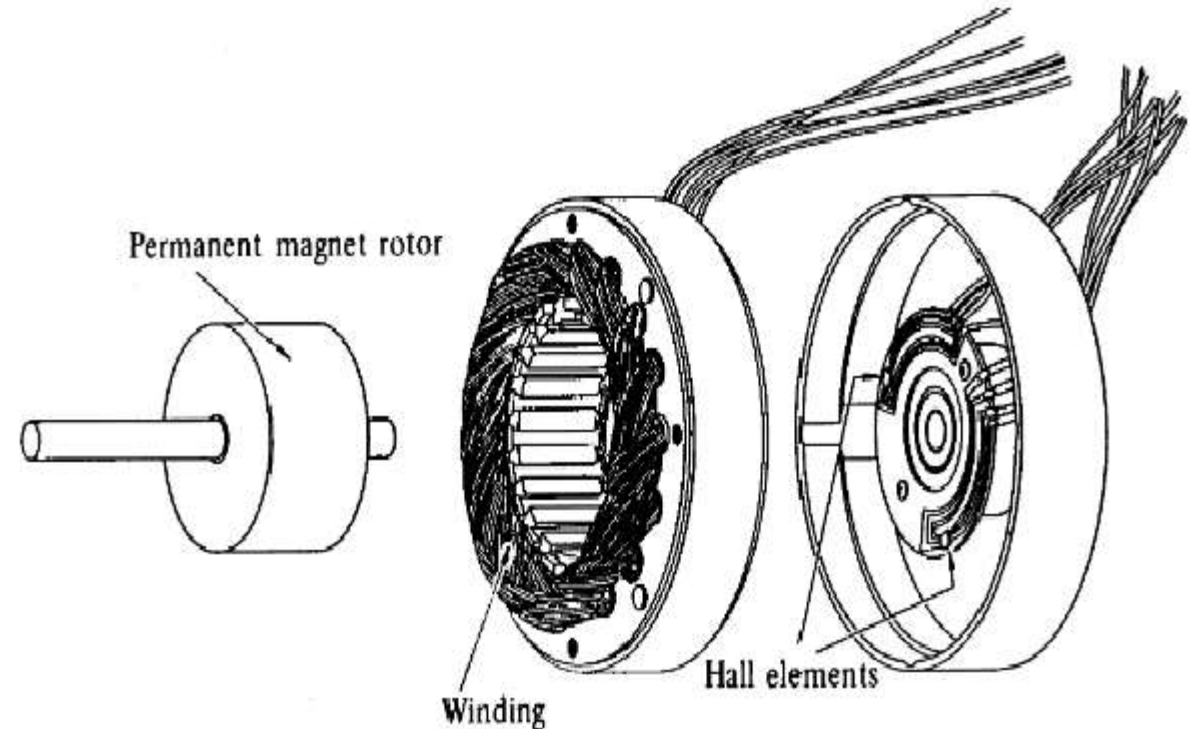
DC Motor

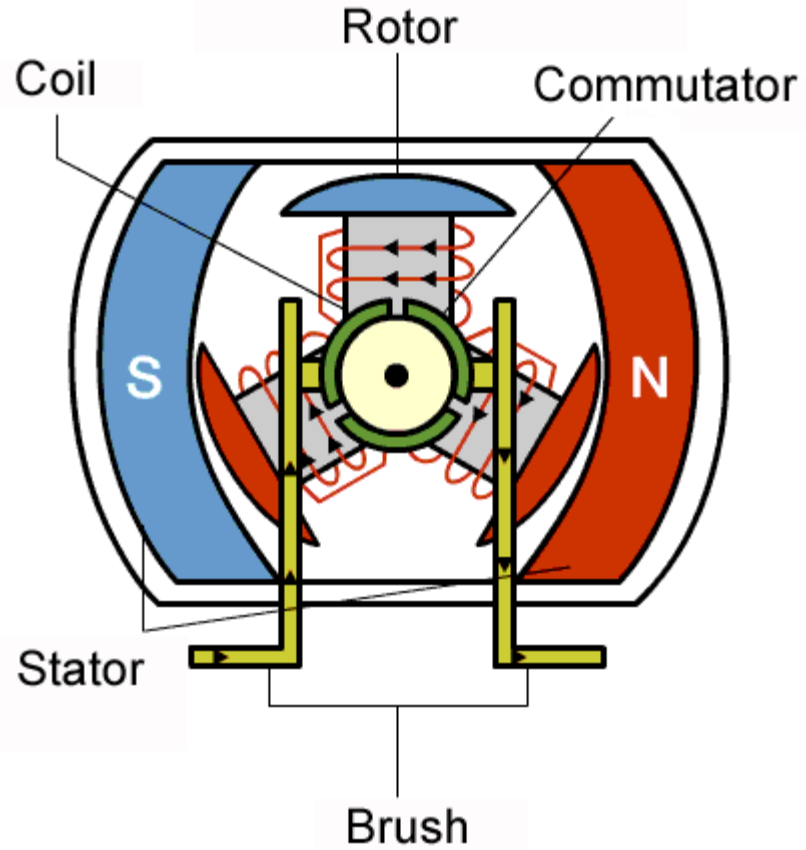


**DC Motor uses brushes
DC Motor has not longer life span
DC Motor is costly
All DC Motors are single phase**

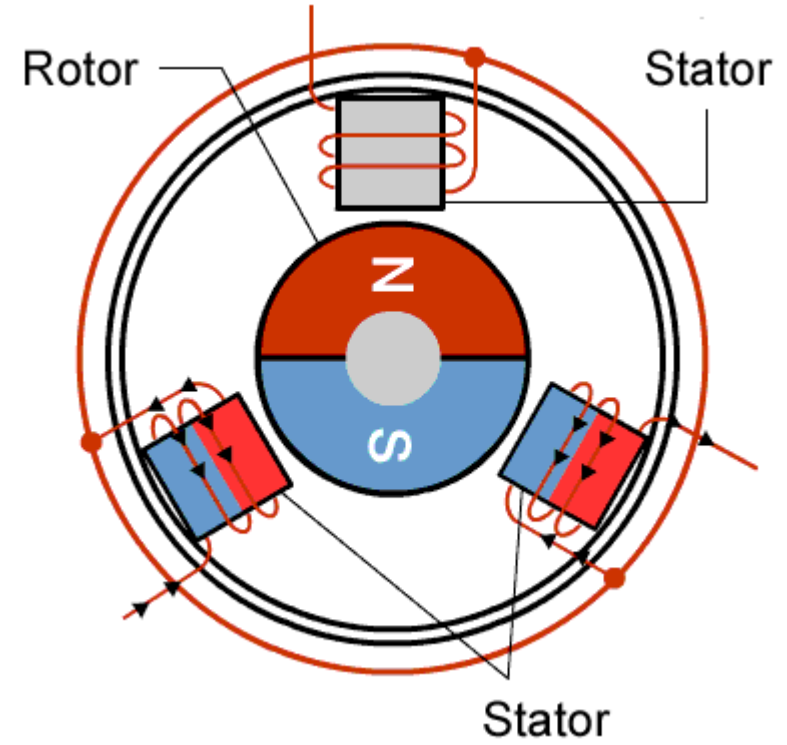
Brushless DC Motors

- Brushless DC motors operate on the same principle of magnetic attraction and repulsion as brush motors, but they are constructed somewhat differently. Instead of a mechanical commutator and brushes, the magnetic field of the stator is rotated by using electronic commutation. This requires the use of active control electronics.





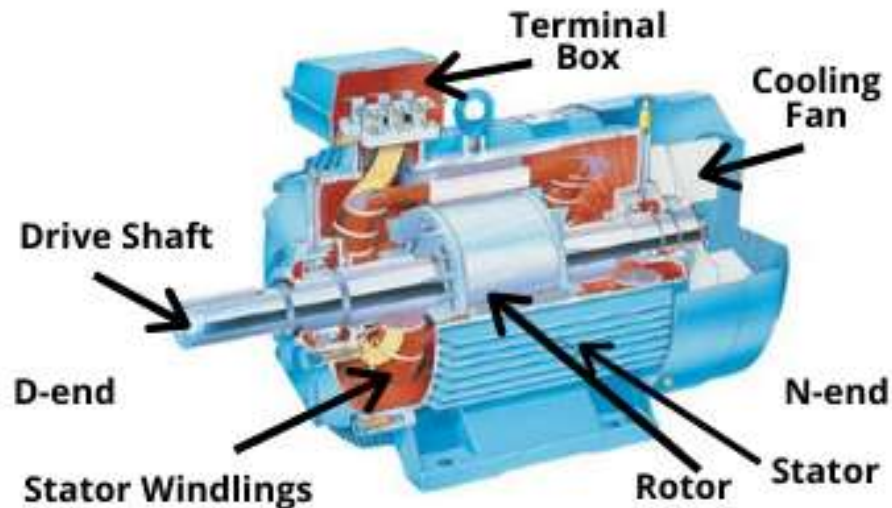
Brushed DC Motor



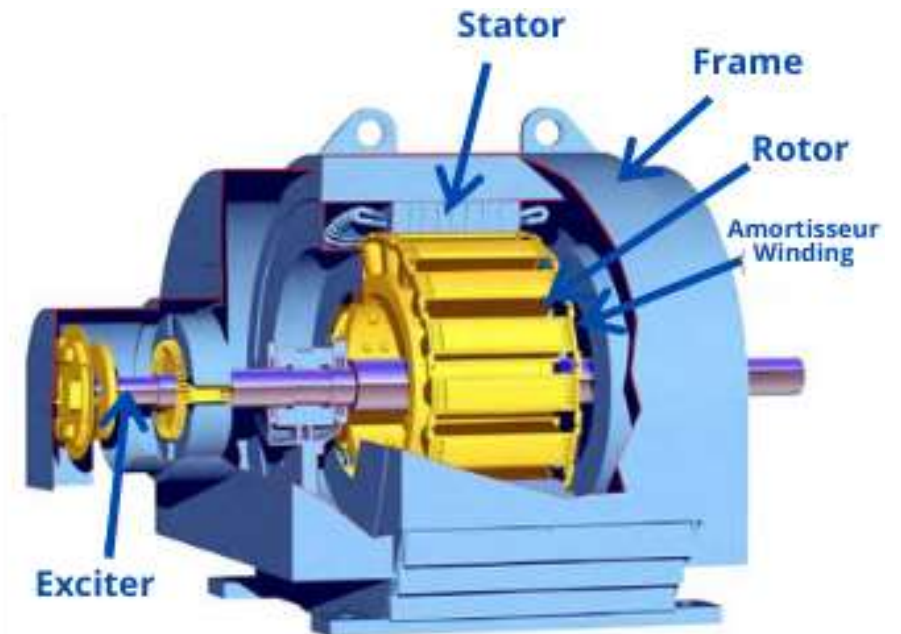
brushless DC motors

AC Motors

- An AC motor or alternating current motor is an electric motor that consists of a stator with a coil that is supplied with alternating current to convert electric current into mechanical power. The stator is the stationary part of the motor while the rotor is the rotating part. AC motors can be single or three phase with three phase motors mainly used for bulk power conversion. Single phase AC motors are used for small power conversions.
- There are two types of AC motors, which are synchronous and asynchronous (induction) motor. In a synchronous motor, the rotation of the shaft is at the same pace as the frequency of the applied current with multiphase AC electromagnets on the stator that produce a rotating magnetic field. An asynchronous (induction) motor is a single excited motor where current is applied to one part of the motor, the stator. Flux from the stator cuts the short circuited coil in the rotor, which feels torque that makes the rotor rotate.



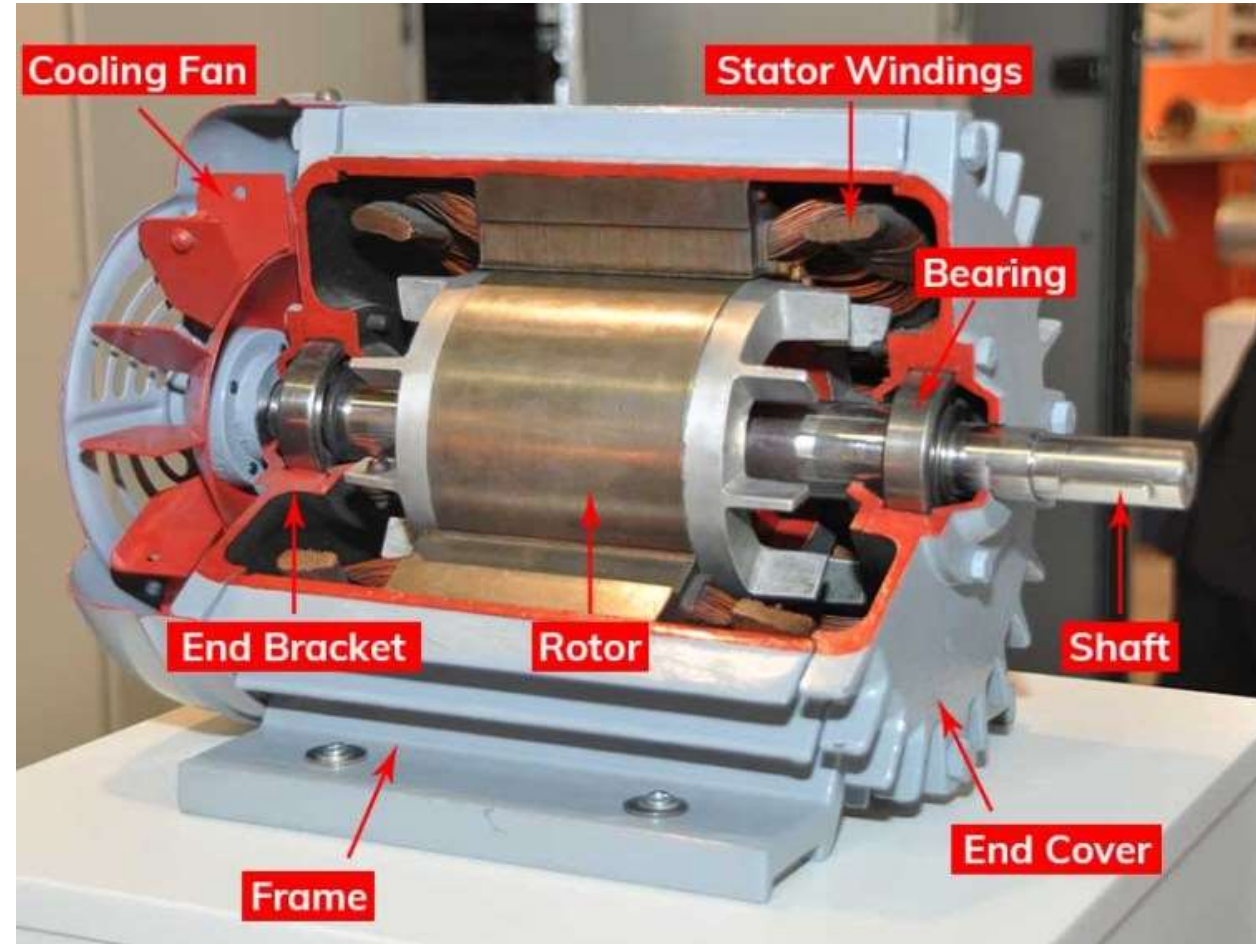
Induction Motor



Synchronous Motor

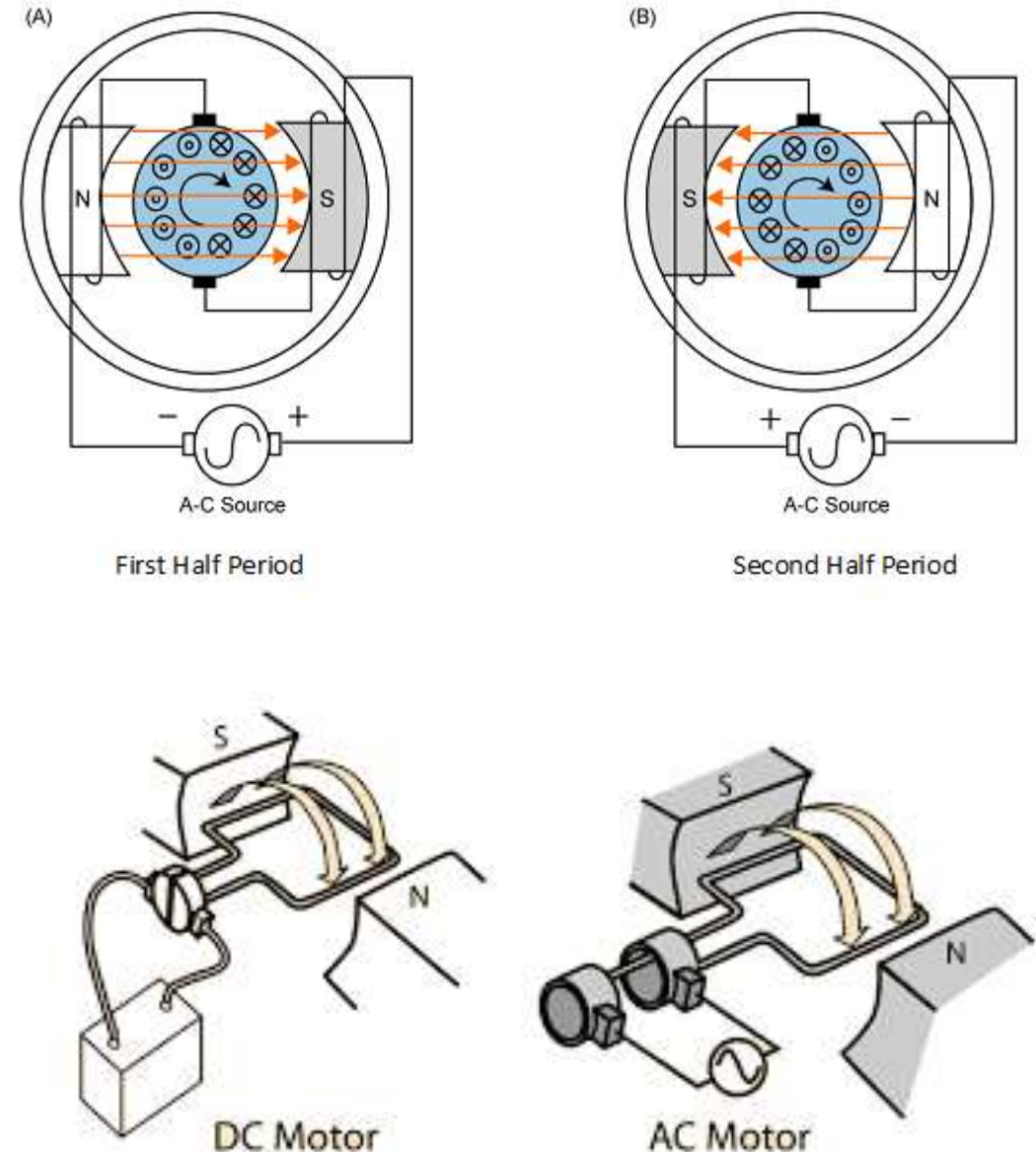
Basic Construction

- The main components of an AC motor are the stator, stationary outer drum, and the rotor, the rotating inner portion attached to the motor shaft. The stator and the rotor produce rotating magnetic fields. The winding of the stator that creates the rotating field is created by alternating current.
- In an AC motor the winding serves as the armature and field winding. When the stator is connected to an AC supply flux an air gap is formed rotating the flux at a fixed synchronous speed, which produces voltages in the stator and rotor winding.

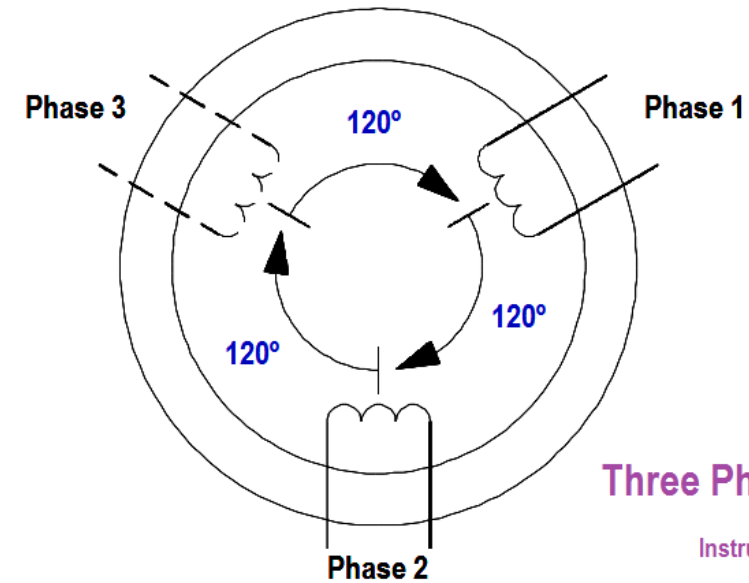
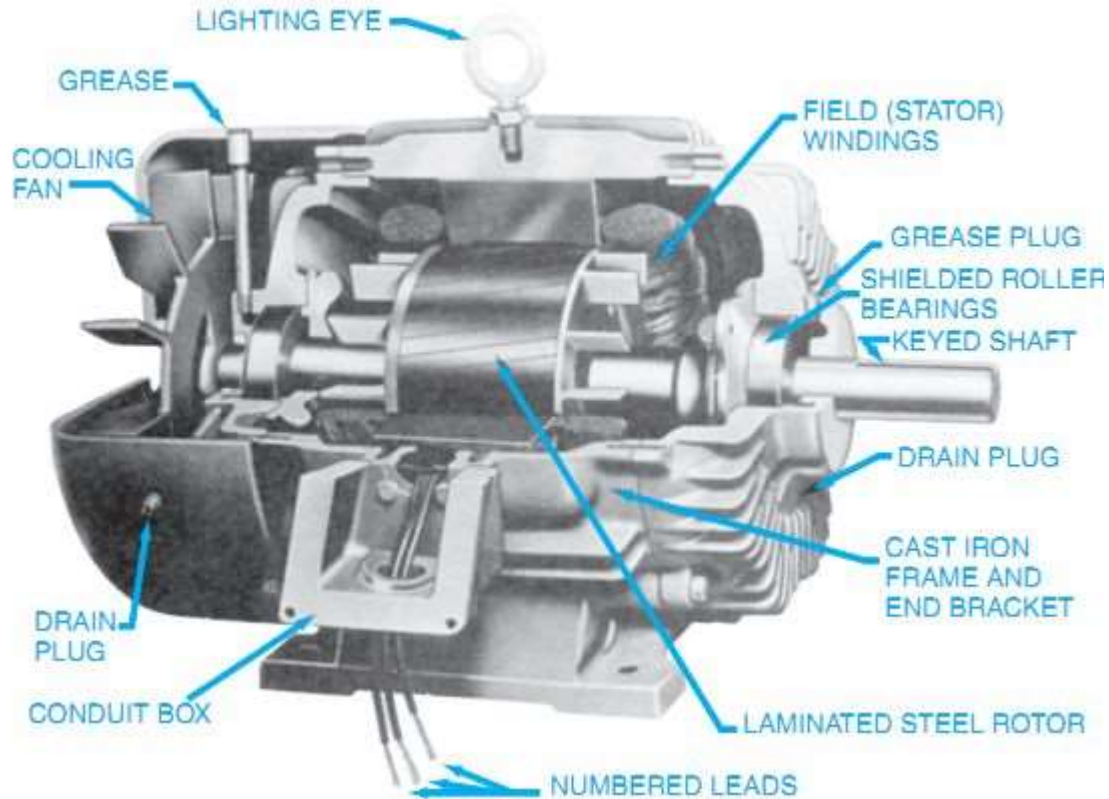


Basic Operation

- The fundamental operation of an AC Motor depends on the principle of magnetism. The simple AC Motor contains a coil of wire and two fixed magnets surrounding a shaft. When an electric (AC) charge applies to the coil of wire, it becomes an electromagnet. This electromagnet generates a magnetic field.
- Inside the stator, there is a solid metal axle, a loop of wire, a coil, a squirrel cage made of metal bars and some other freely rotating metal part that can conduct electricity. In an AC motor you send power to the outer coils that make up the stator. The coils energized in pairs, in sequence, producing a magnetic field that rotates around the outside of the motor.

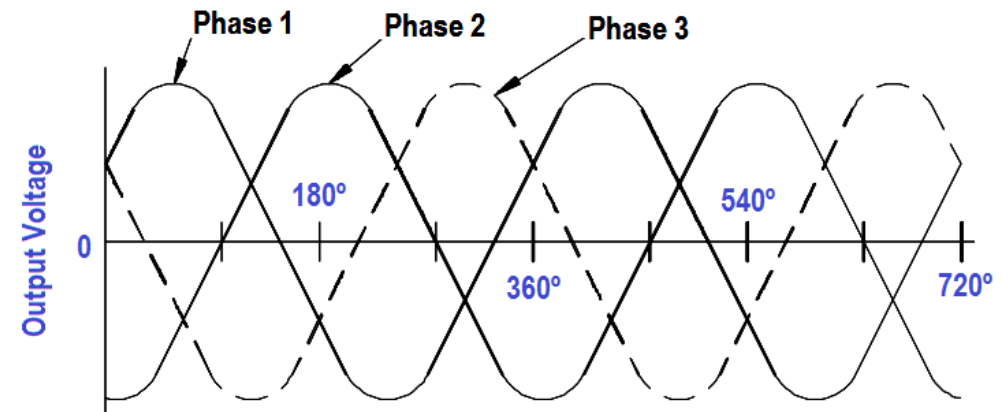


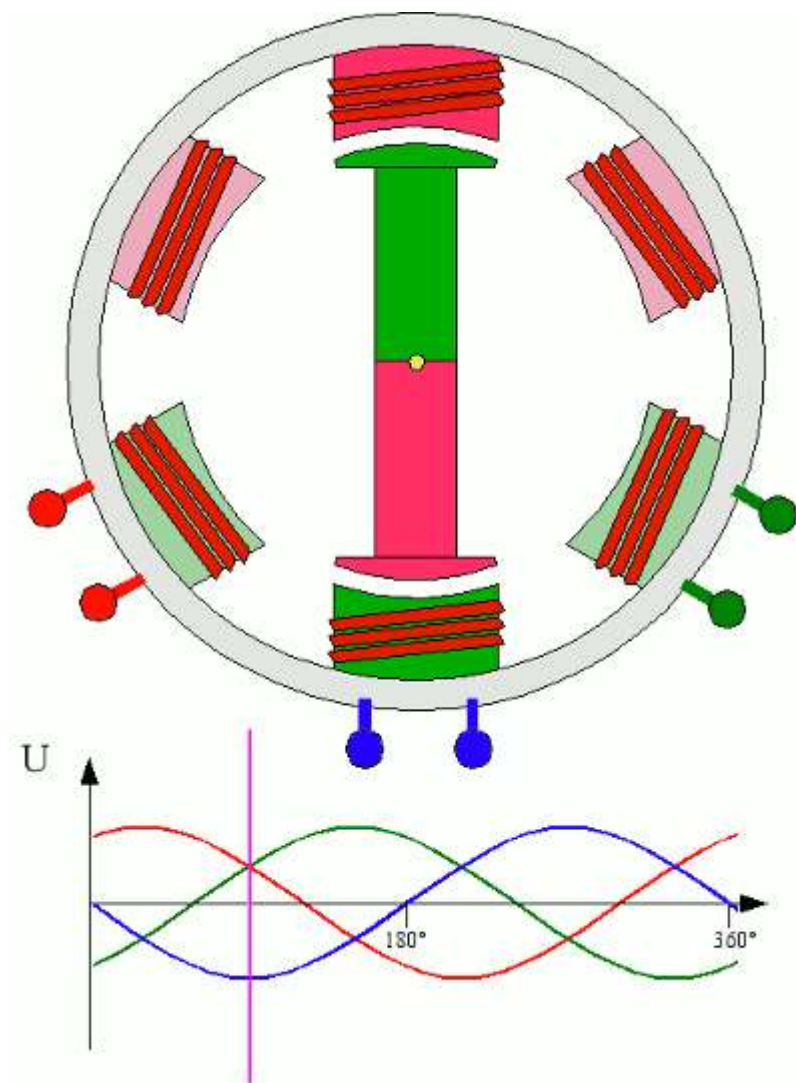
Three phase induction motor



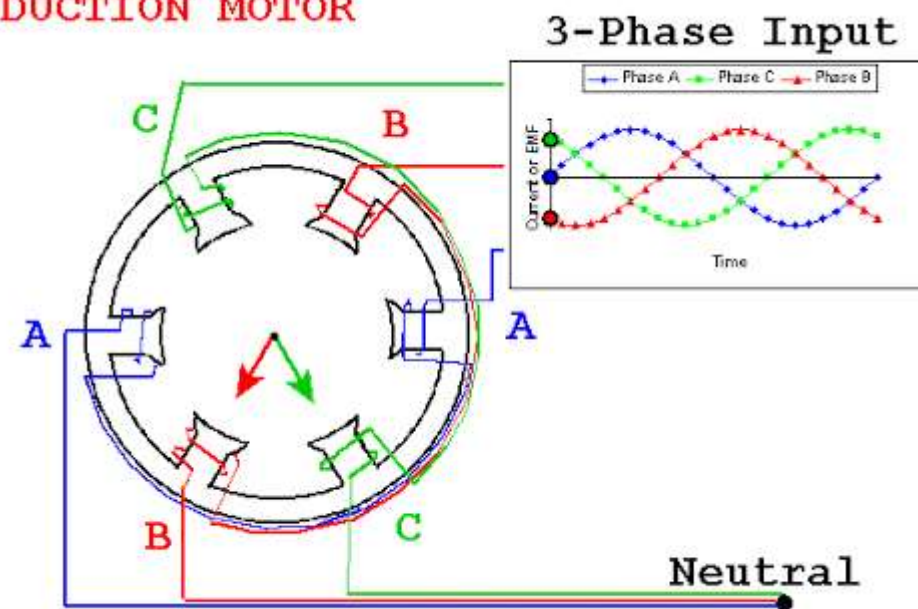
Three Phase AC Generators

InstrumentationTools.com

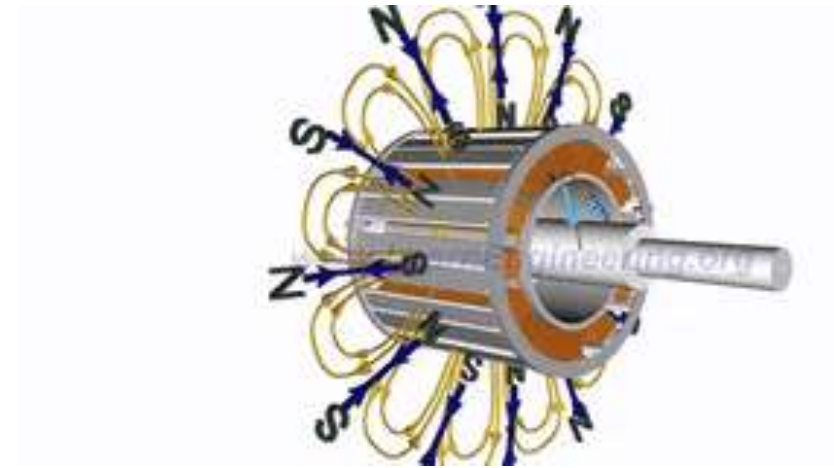
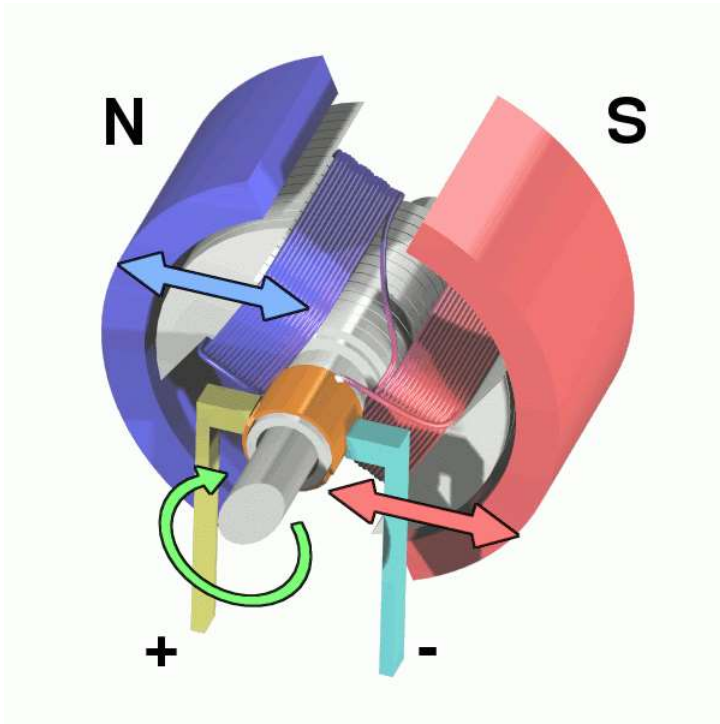
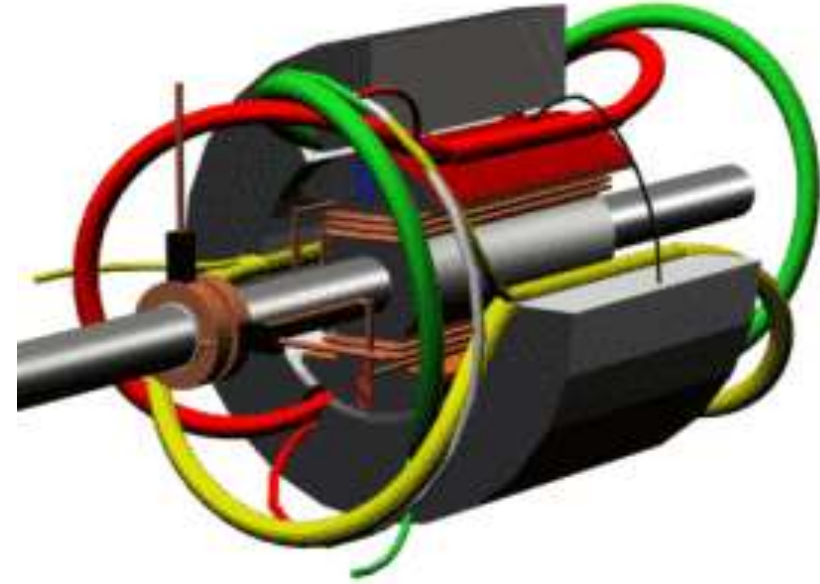


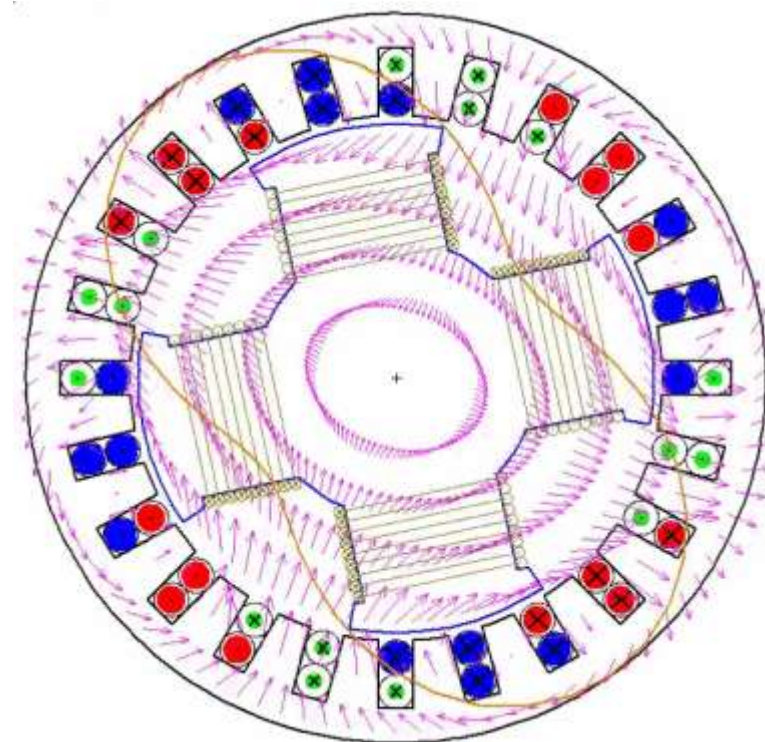
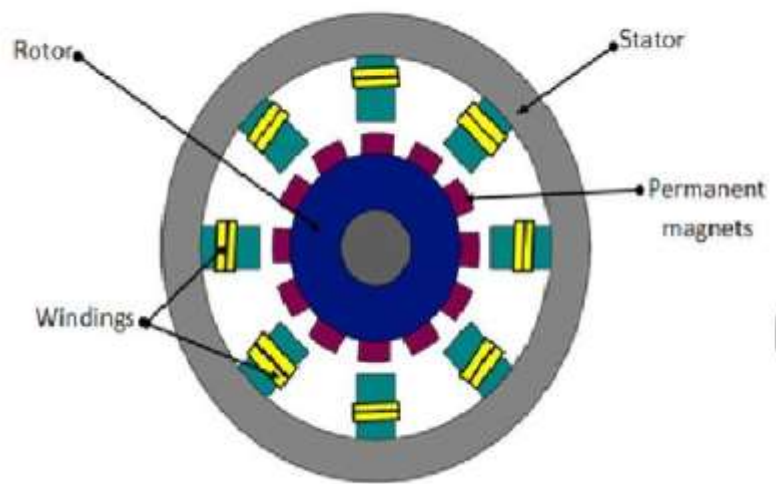


INDUCTION MOTOR



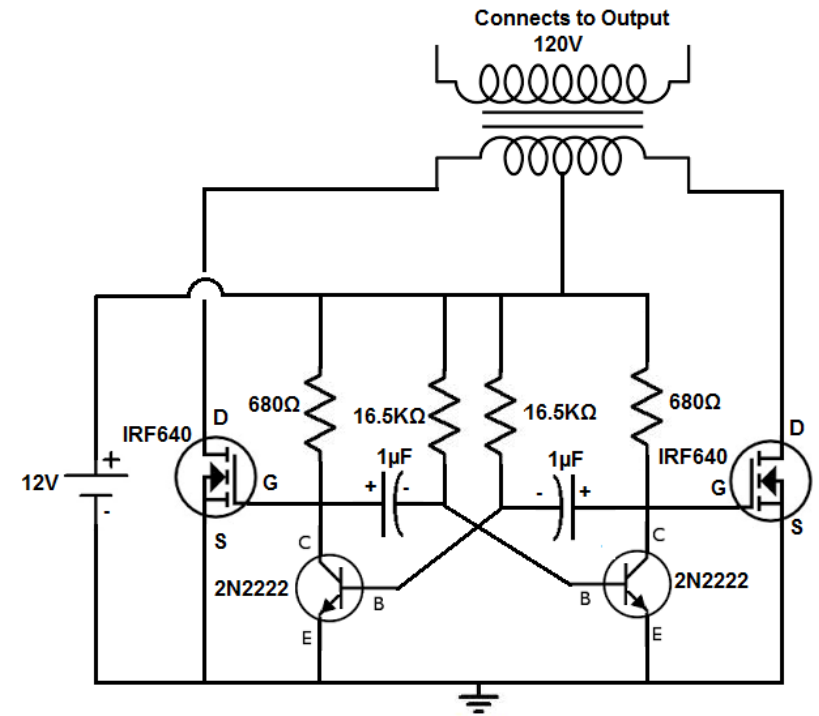
T. Davies 2002





Inverters

- A power inverter, inverter is a power electronic device or circuitry that changes direct current (DC) to alternating current (AC). The resulting AC frequency obtained depends on the particular device employed. Inverters do the opposite of rectifiers which were originally large electromechanical devices converting AC to DC



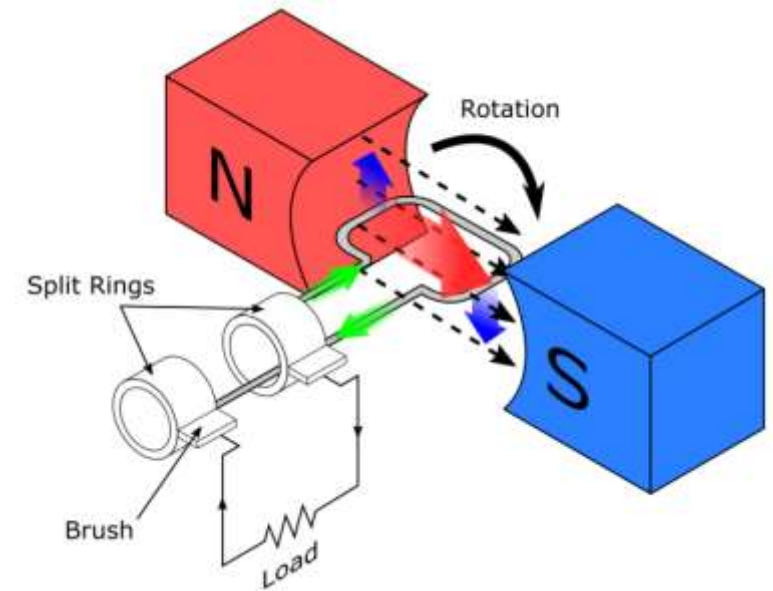
CHARGING SYSTEMS

- A car uses quite a lot of electricity to work the ignition and other electrical equipment. If the power came from an ordinary battery, it would soon run down. So a car has a rechargeable battery and a charging system to keep it topped up.

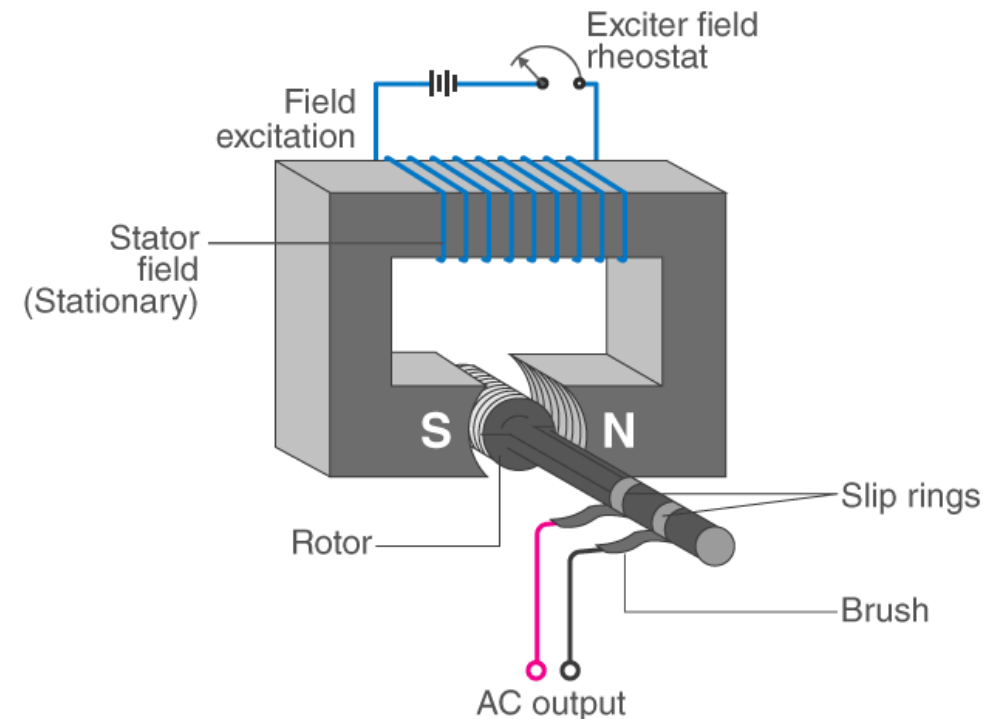


ALTERNATING CURRENT CHARGING SYSTEMS

- The DC generator provided direct current (DC) and was similar to an electric motor in construction. The biggest difference between a generator and a motor is the wiring to the armature. In a motor, the armature receives current from the battery. This creates the magnetic field that opposes the magnetic fields in the motor's coils, which causes the armature to rotate. The armature in a DC generator is driven by the engine. It is not magnetized and the windings simply rotate through the stationary magnetic field of the field windings, inducing a voltage in the conductors inside the armature.

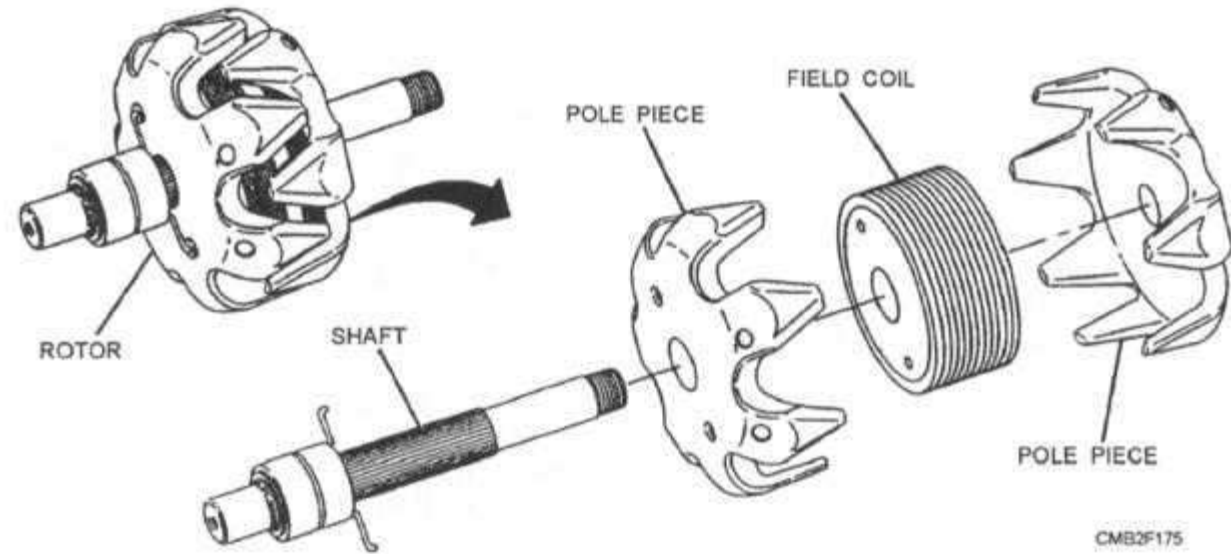


Basic AC Generator



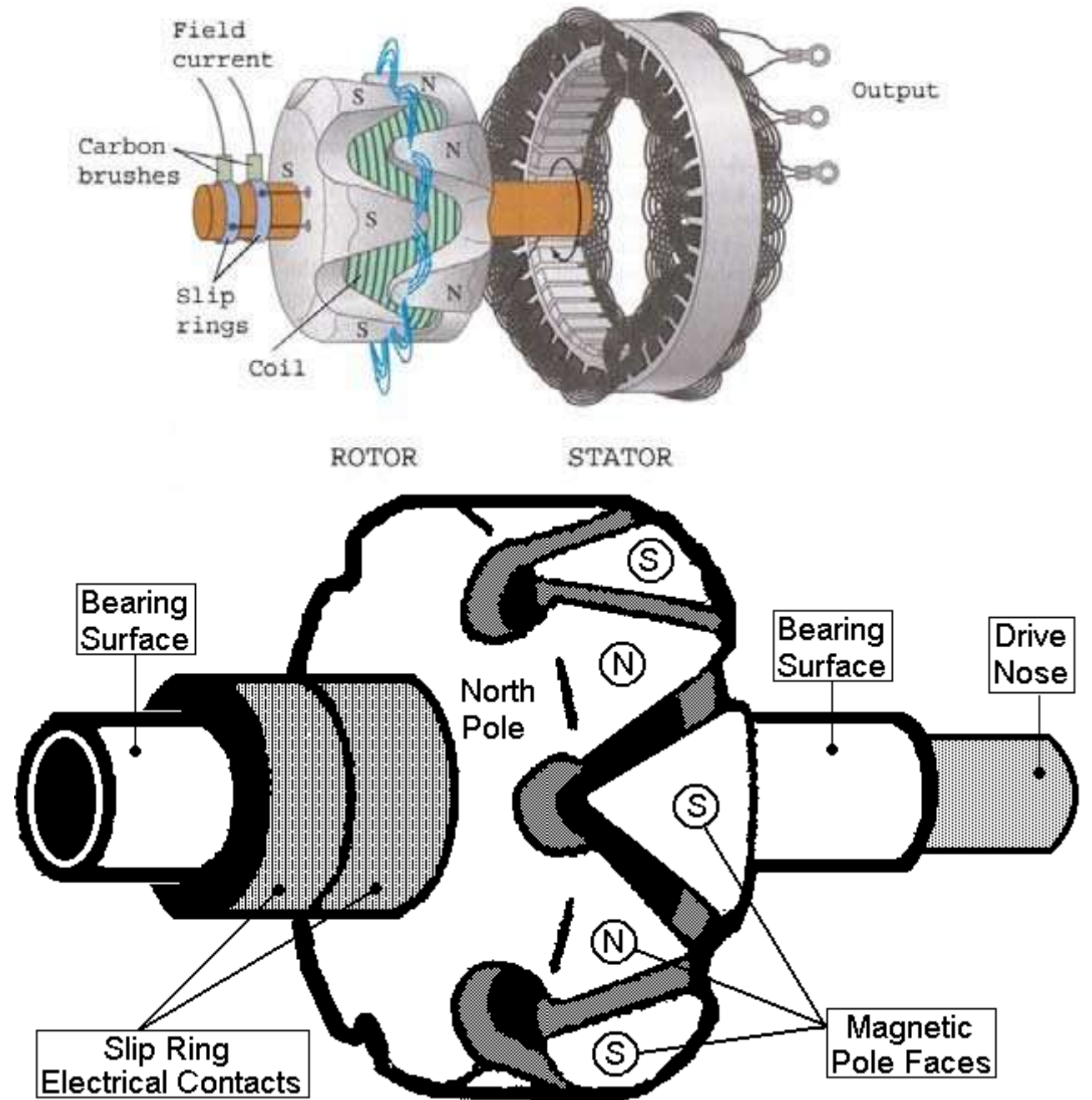
AC Generator Construction

- Rotor The rotor assembly consists of a drive shaft, coil, and two pole pieces. A pulley mounted on one end of the shaft allows the rotor to be spun by a belt driven by the crankshaft pulley.



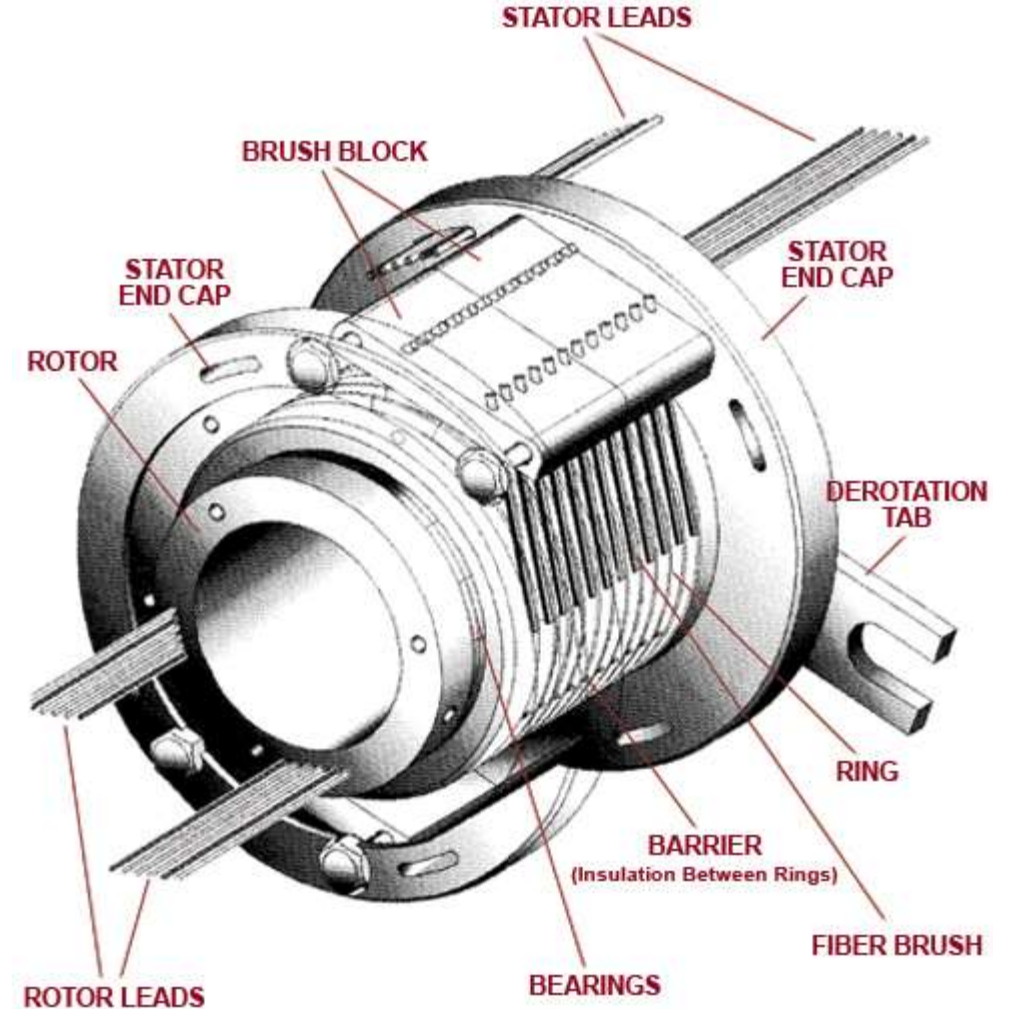
Rotor

- The rotor is a rotating magnetic field inside the alternator. The field coil is simply a long length of insulated wire wrapped around an iron core. The core is located between the two sets of pole pieces



Slip Rings and Brushes

- The brushes of the slip rings help to connect both ends of the windings and connects with the three insulated slip rings. When an electrical machine is operated, the brushes start to lift up automatically. After this, the electrical current and signal transfer directly from the stator to the rotor parts

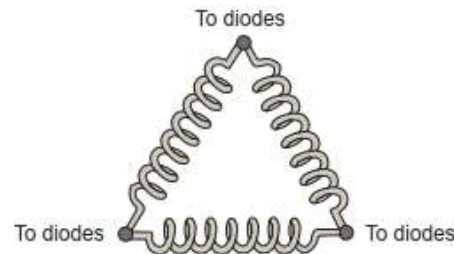


Stator

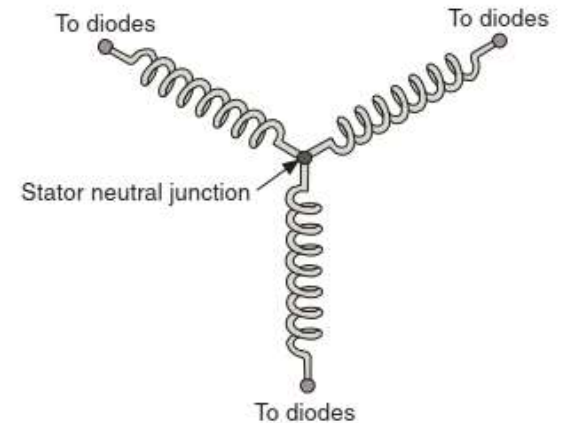
- The stator is the stationary member of the generator. It is made up of a number of conductors, or wires, into which the voltage is induced. Most AC generators use three windings to generate the required amperage output. They can be arranged in either a delta configuration or a wye configuration



Delta connection

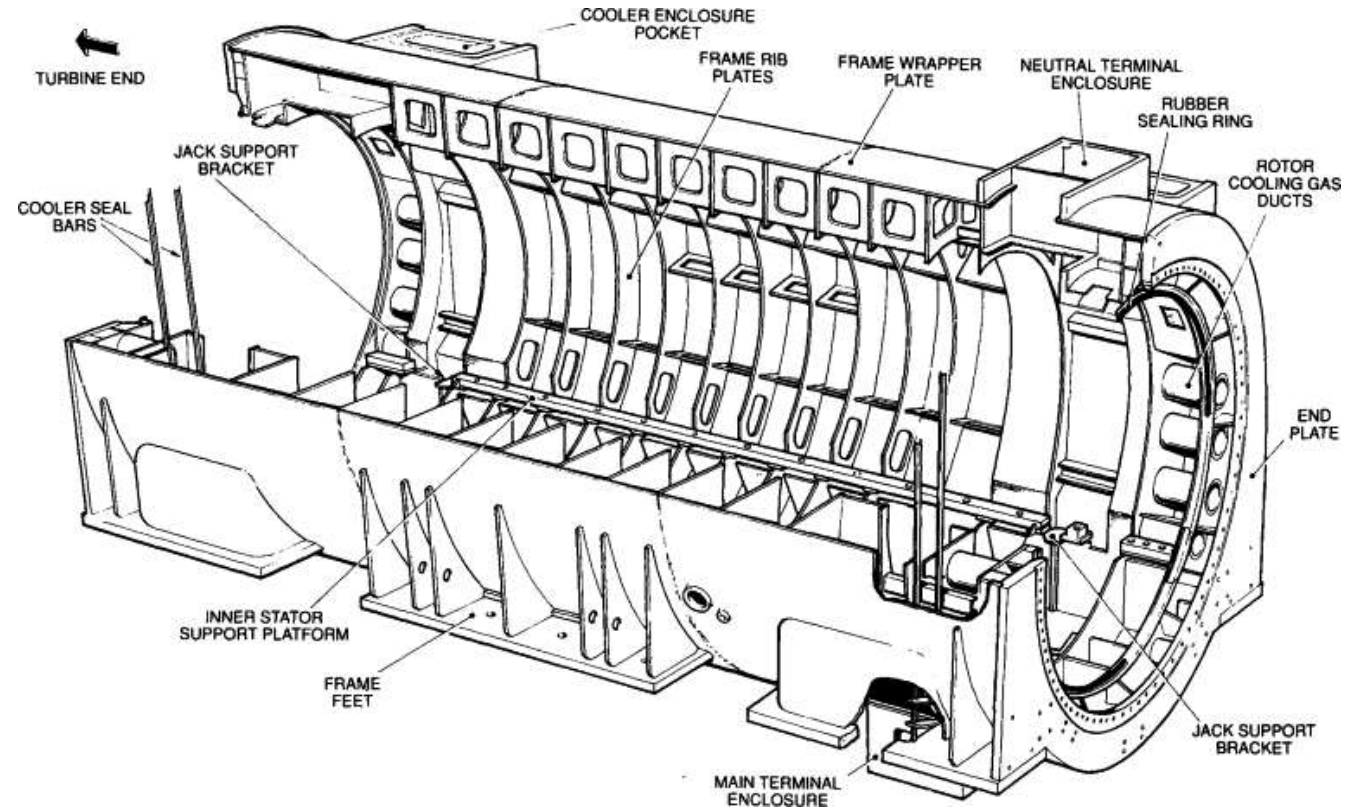


Star (Y) connection



End Frame Assembly

The end frame assembly, or housing, contains the bearings for the rotor shaft. Each end frame also has built-in ducts so the air from the rotor shaft fan can pass through the AC generator.

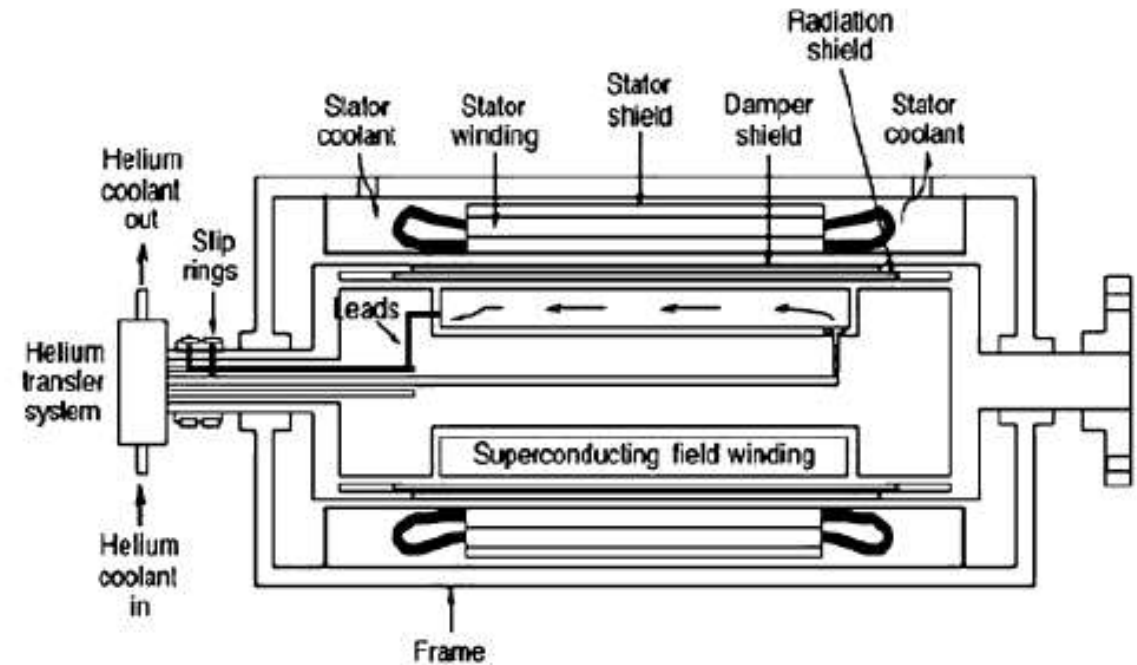


Cooling Fans

- Cooling Fans Behind the drive pulley on most AC generators is a cooling fan that rotates with the rotor. This cooling fan draws air into the housing through the openings at the rear of the housing



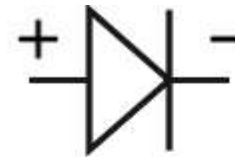
- **Liquid-Cooled Generators**
Another recent design uses liquid cooling. Using water or coolant to cool a generator is a very efficient way to keep diode temperatures down.



AC GENERATOR OPERATION

Diodes

- A diode is a semiconductor device that essentially acts as a one-way switch for current. It allows current to flow easily in one direction, but severely restricts current from flowing in the opposite direction.
- Diodes are also known as **rectifiers** because they change alternating current (AC) into pulsating direct current (DC). Diodes are rated according to their type, voltage, and current capacity.



Forward biased



Reverse biased



Ideal diode (forward biased)

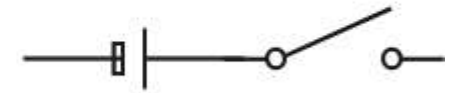


Ideal diode(reverse biased)



0.7V

Practical diode (forward biased)

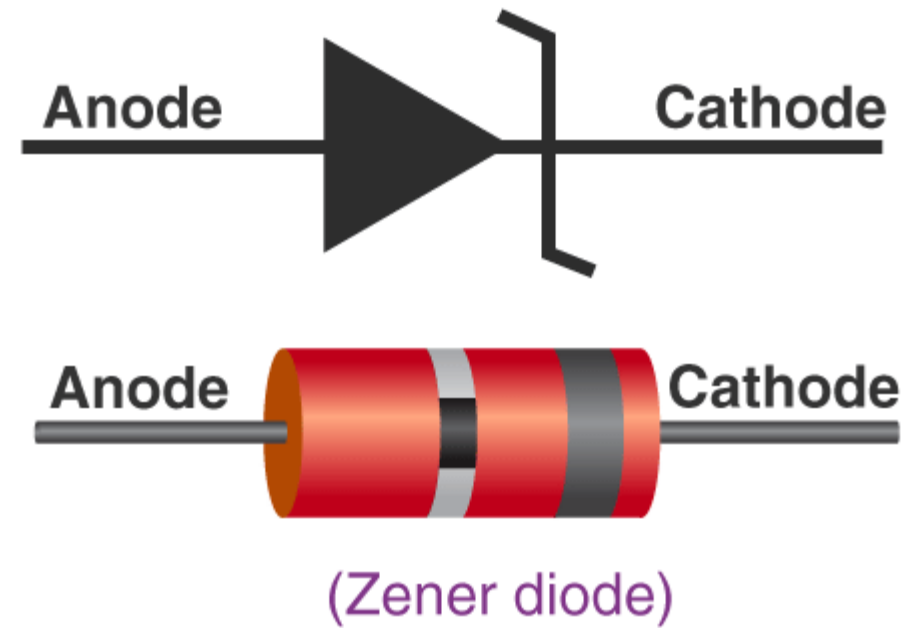


0.7V

Practical diode (reverse biased)

Zener Diode

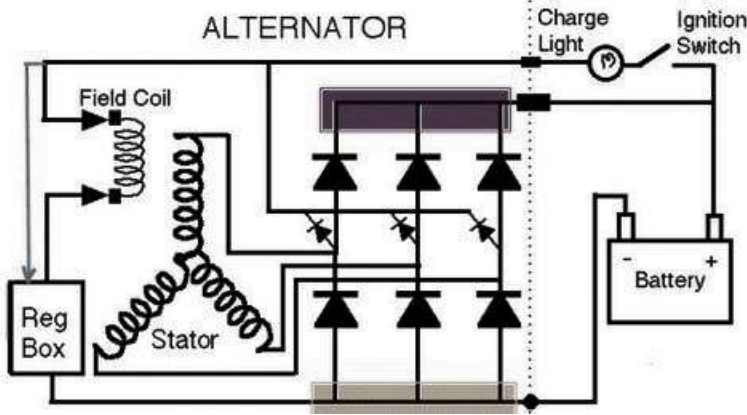
- A Zener diode is a special type of diode designed to reliably allow current to flow "backwards" when a certain set reverse voltage, known as the Zener voltage, is reached.



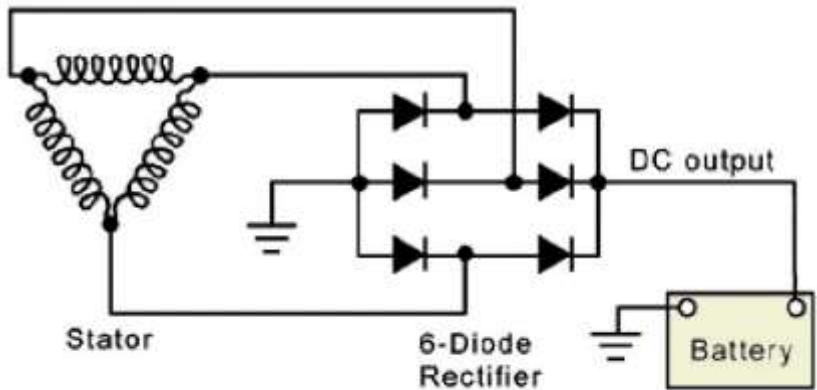
DC Rectification

- A rectifier is a device that converts an oscillating two-directional alternating current (AC) into a single-directional direct current (DC). Rectifiers can take a wide variety of physical forms, from vacuum tube diodes and crystal radio receivers to modern silicon-based designs.
- The simplest rectifiers, called half-wave rectifiers, work by eliminating one side of the AC, thereby only allowing one direction of current to pass through. Since half of the AC power input goes unused, half-wave rectifiers produce a very inefficient conversion. A more efficient conversion alternative is a full-wave rectifier, which uses both sides of the AC waveform. For information on how half-wave and full-wave rectifiers operate,

A wye stator wired to six diodes



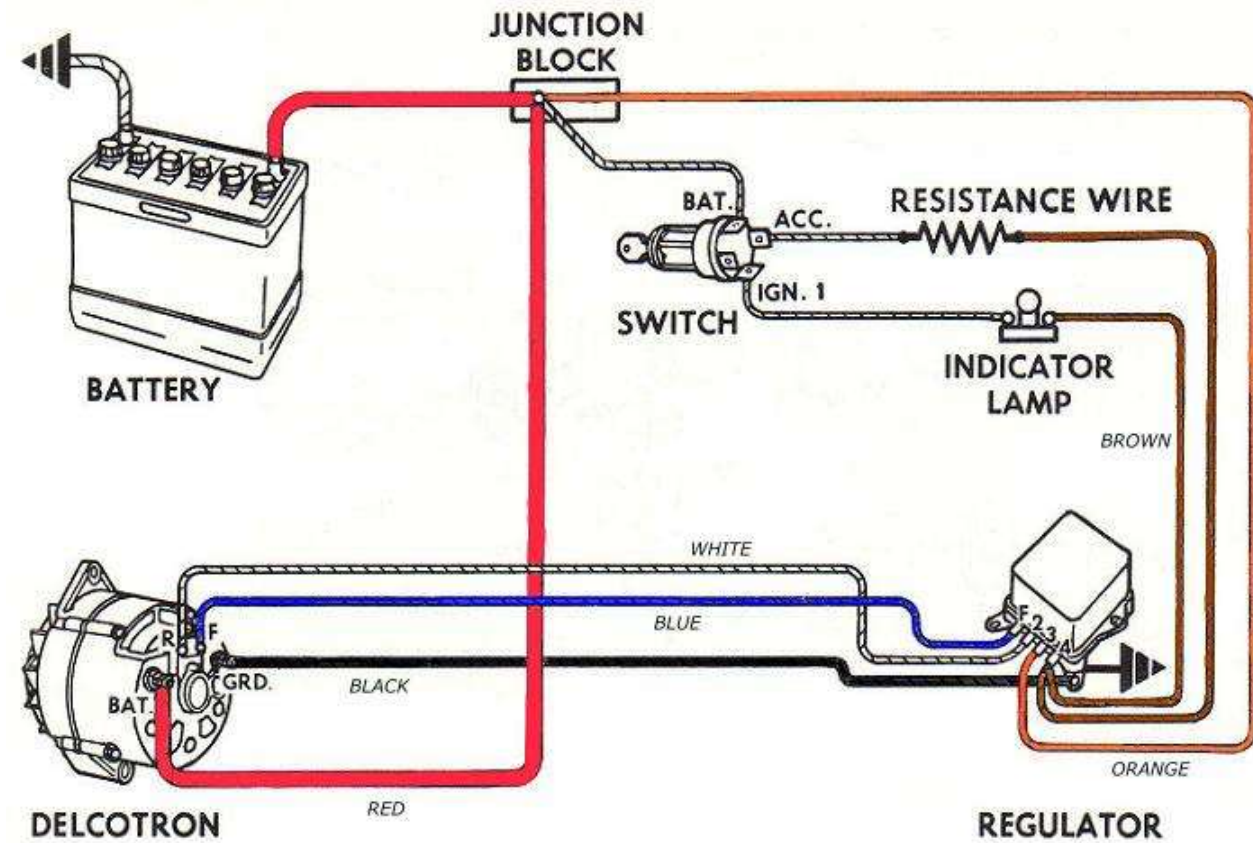
A delta stator wired to six diodes.



	Full-Wave Rectification	Half-Wave Rectification
Circuit Configuration		
Input Voltage Waveform		
Voltage Waveform After Rectification		

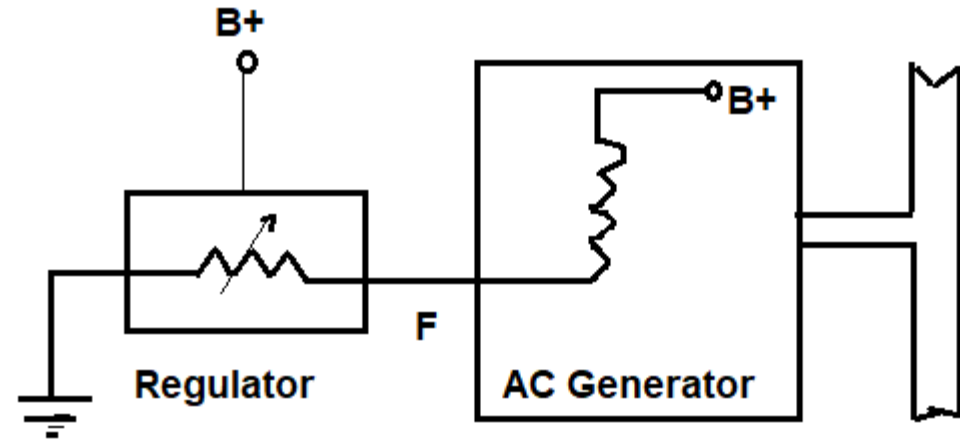
VOLTAGE REGULATION

- Car voltage regulators are responsible for maintaining a constant voltage level in the electrical system, regardless of changes in load or supply conditions.
- The regulator is typically located in the engine compartment, and it regulates the voltage by converting the alternating current (AC) into direct current (DC).
- The regulator consists of two main components: a rectifier and a regulator. The rectifier converts the AC into DC, and the regulator controls the amount of current that flows through the rectifier.
- The regulator is typically controlled by a computer, which adjusts the flow of current based on input from sensors.

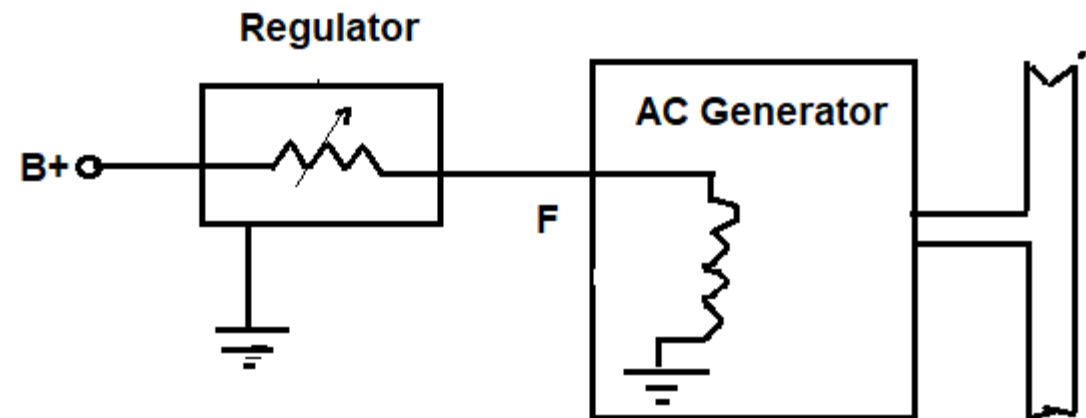


Field Circuits

- A regulator controls field current and is connected in one of three ways to the rotor
1. The A-circuit
 2. The B-circuit
 3. The isolated field



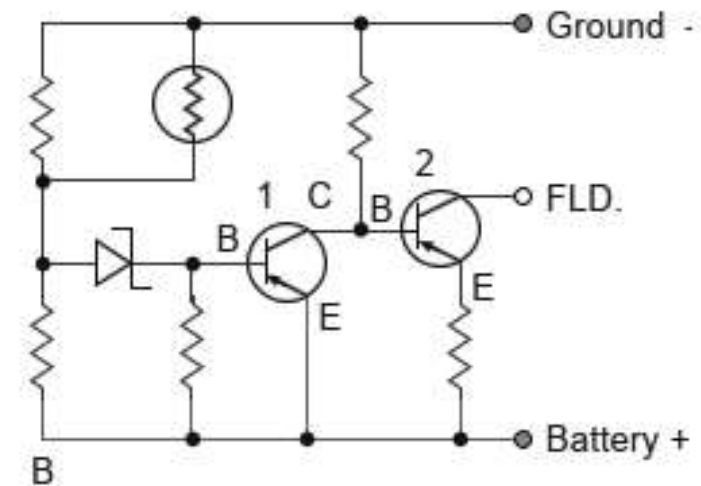
An A-circuit



A B-circuit

Electronic Regulators

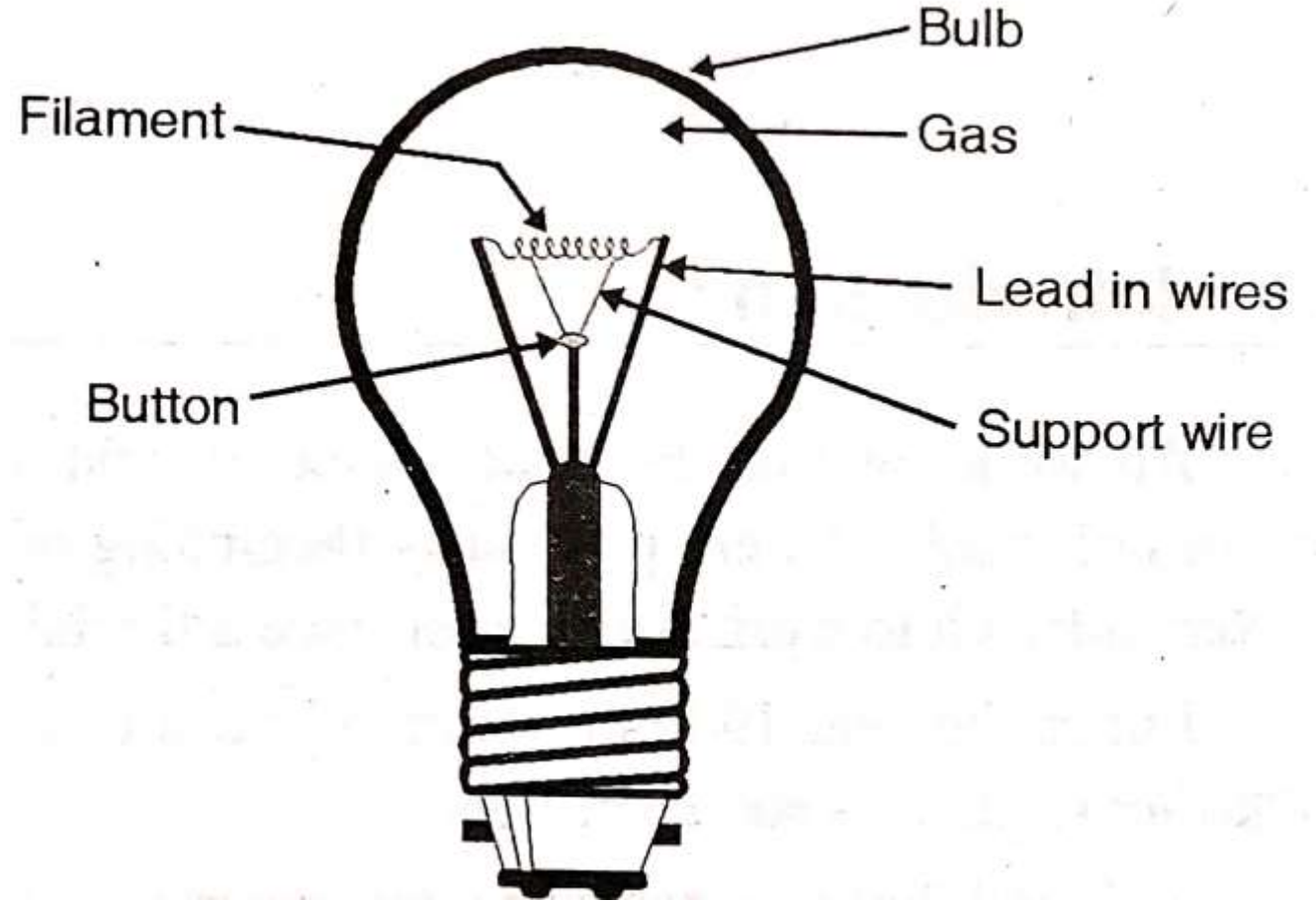
- Integrated circuit voltage regulators
- **Fail-Safe Circuits** To prevent simple electrical problems from causing high-voltage outputs that can damage delicate electronic components



circuit of an electronic regulator with a zener diode.

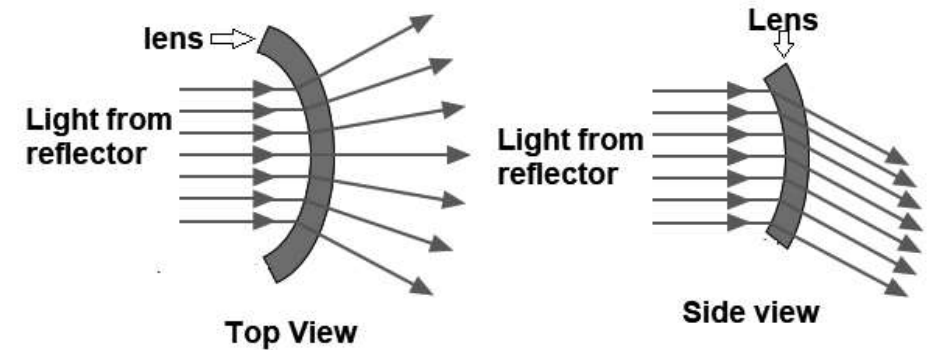
LAMPS

- A lamp generates light as current flows through the filament. This causes it to get very hot. The changing of electrical energy to heat energy in the resistive wire filament is so intense that the filament starts to glow and emits light.

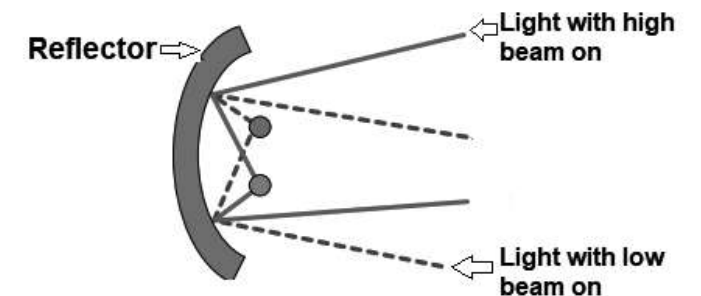


HEADLIGHTS

- Seal beam lamps are headlights which are housed inside a sealed unit air tight, that contains a filament, reflector, and lens. The curved reflector is sprayed with vaporized aluminum and the inside of the lamp is normally filled with argon gas. The reflector intensifies the light produced by the filament

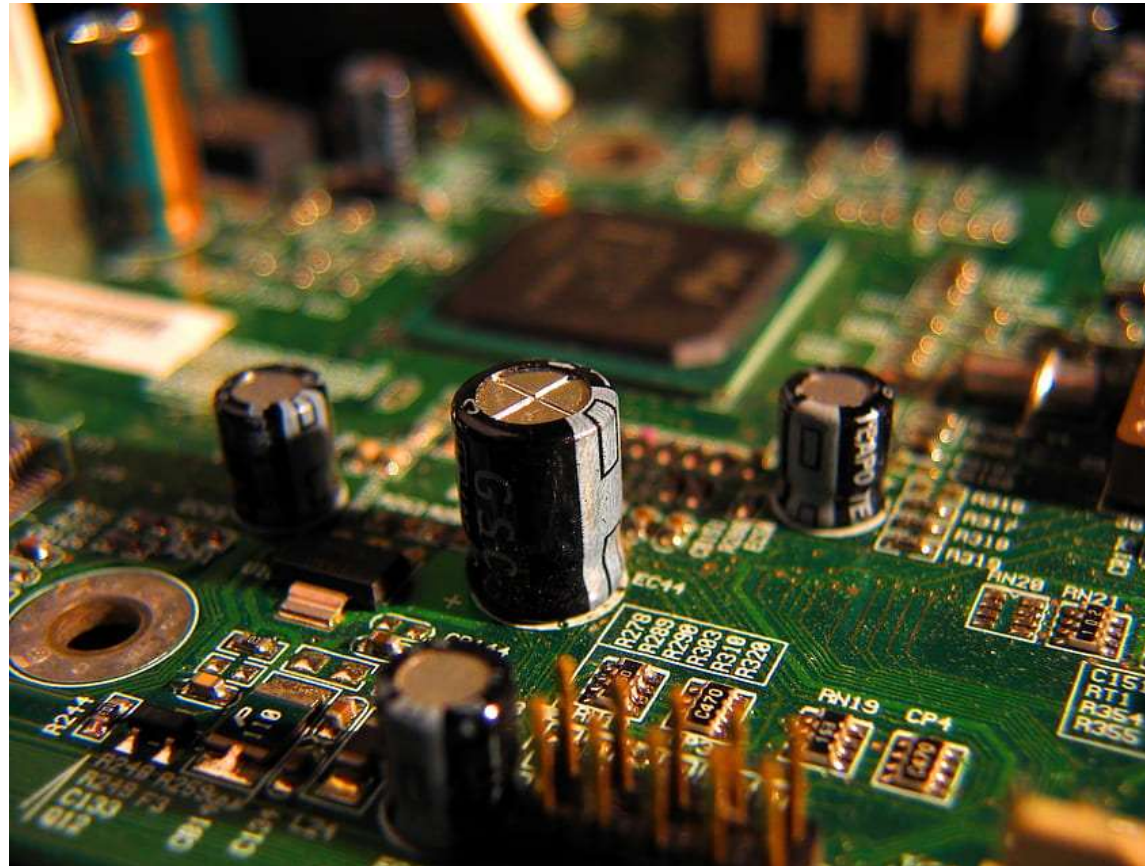


The reflector intensifies the light produced by the filament, and the lens directs the light to form a broad flat beam.

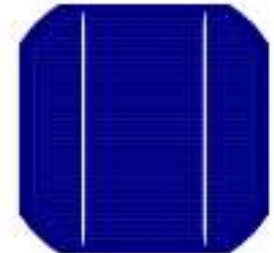


Filament placement controls the projection of the light beam.

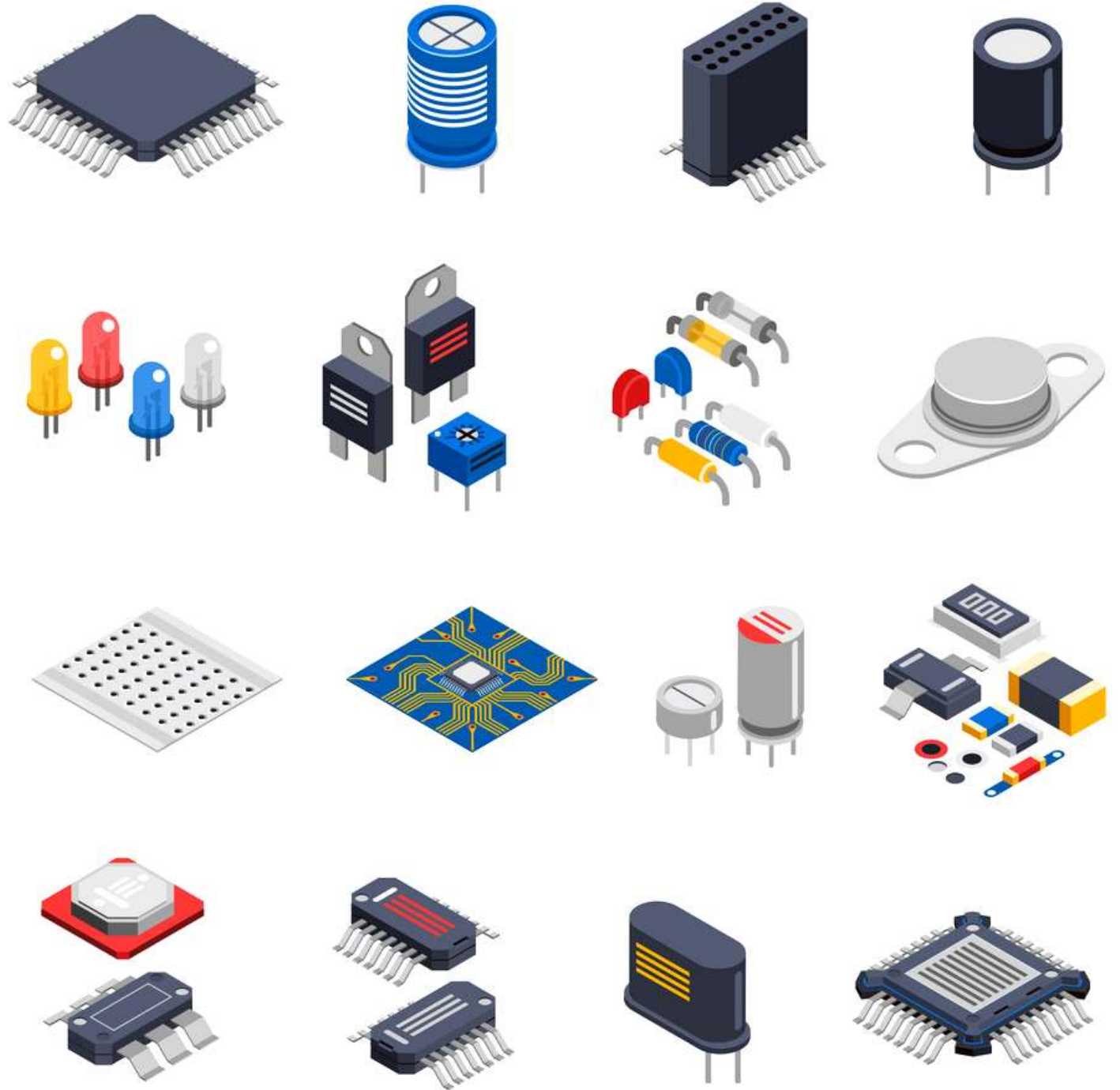
FUNDAMENTALS OF ELECTRONICS



Semiconductors



- A **semiconductor** is a material product usually comprised of silicon, which conducts electricity more than an insulator, such as glass, but less than a pure conductor, such as copper or aluminum. Their conductivity and other properties can be altered with the introduction of impurities, called doping, to meet the specific needs of the electronic component in which it resides.

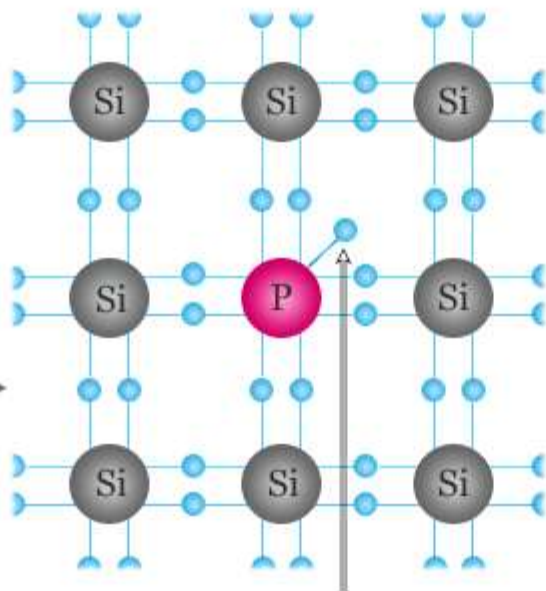


n-type semiconductor

Four valence electrons
Silicon (Si)



Adding phosphorus to pure silicon crystal results in a surplus of electron



Free electron

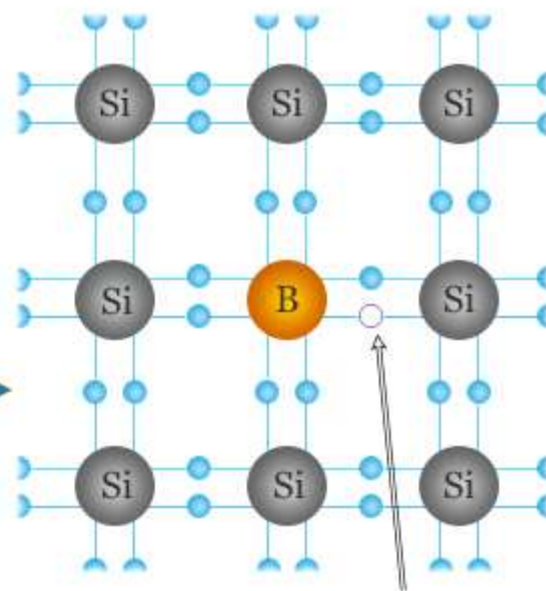
Five valence electrons
Phosphorus (P)

p-type semiconductor

Four valence electrons
silicon (Si)



Adding boron to pure silicon crystal results in lack of an electron

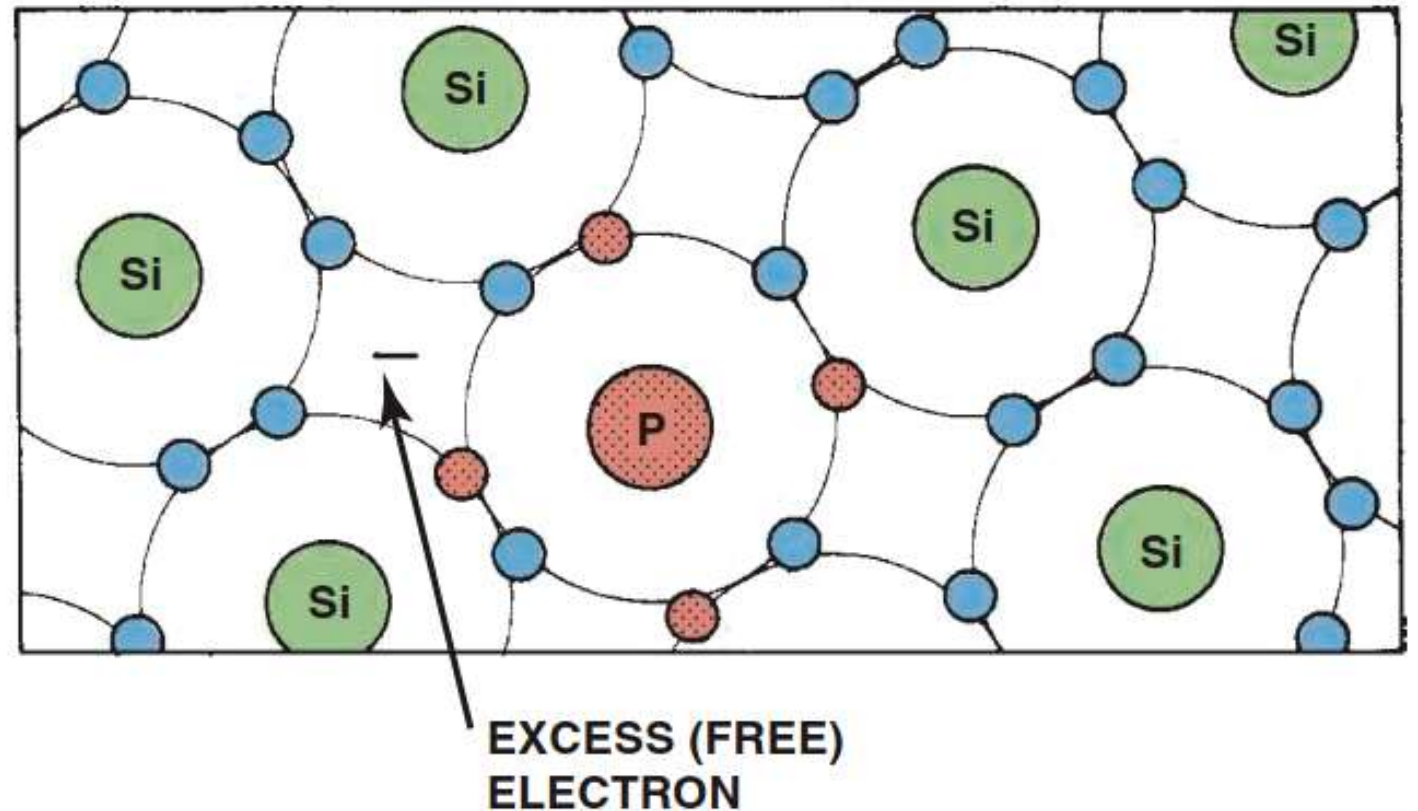


Hole

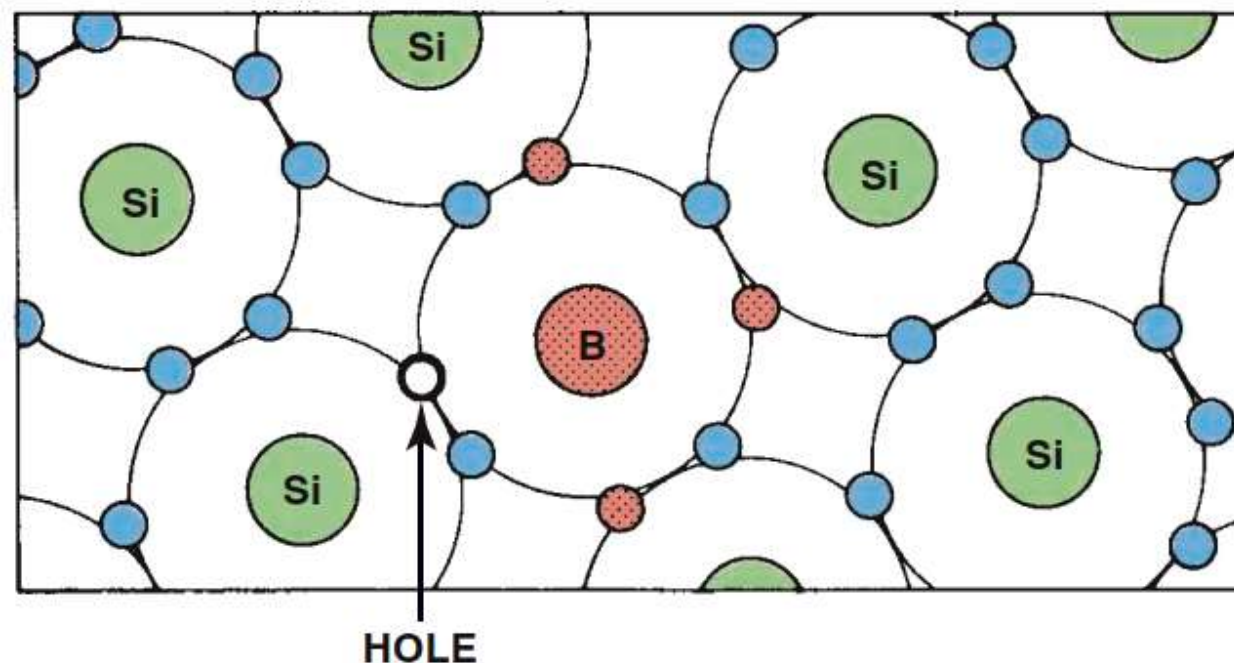
Three valence electrons
boron (B)

Semiconductors

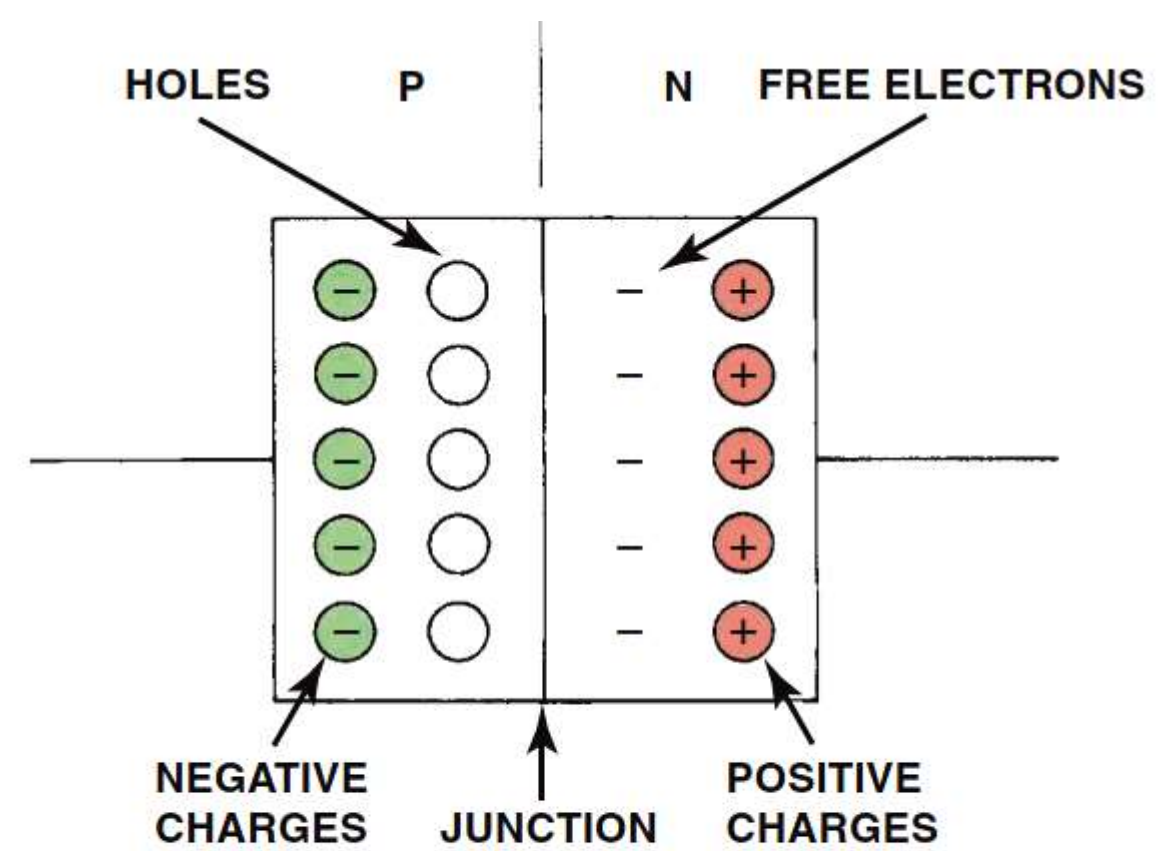
- Semiconductors. Semiconductors are materials which have a conductivity between conductors (generally metals) and nonconductors or insulators (such as most ceramics). Semiconductors can be pure elements, such as silicon or germanium, or compounds such as gallium arsenide or cadmium selenide.



N-type material. Silicon (Si) doped with (phosphorus) with five electrons in the outer orbit results in an extra free electron



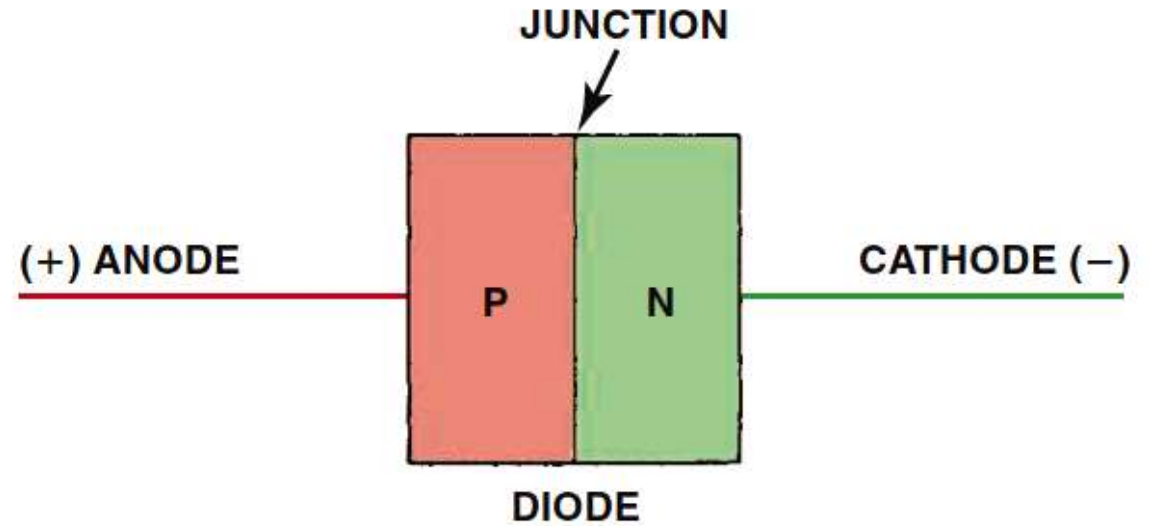
P-type Material. Silicon (Si) doped with a boron (B), With three electrons in the outer orbit results in a hole capable of attracting an electron.



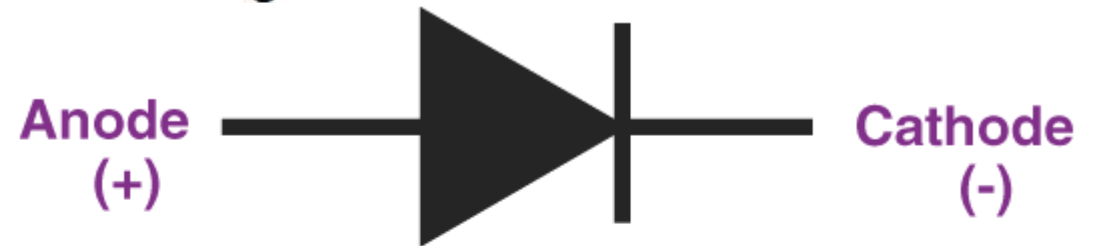
Unlike charges attract and the current carriers (electrons and holes) move toward the junction

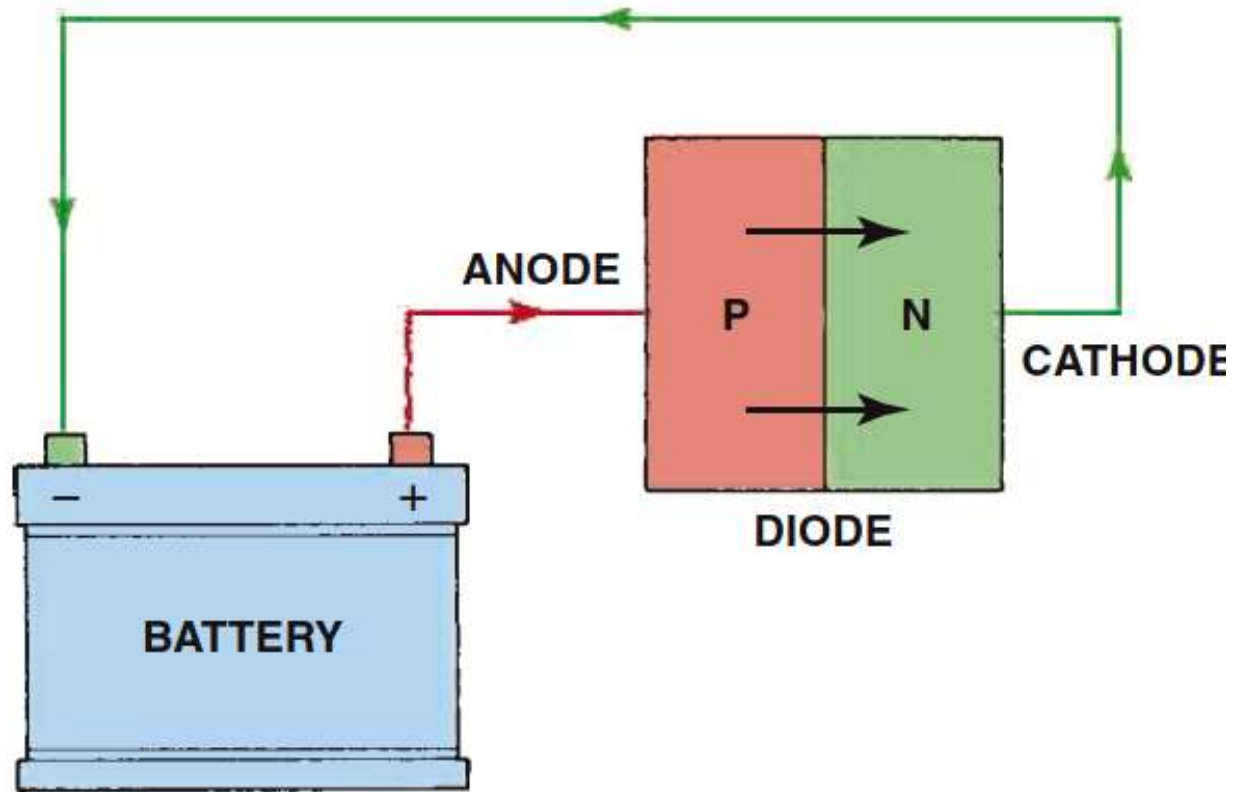
Diode

- A diode is a semiconductor device that essentially acts as a one-way switch for current. It allows current to flow easily in one direction, but severely restricts current from flowing in the opposite direction

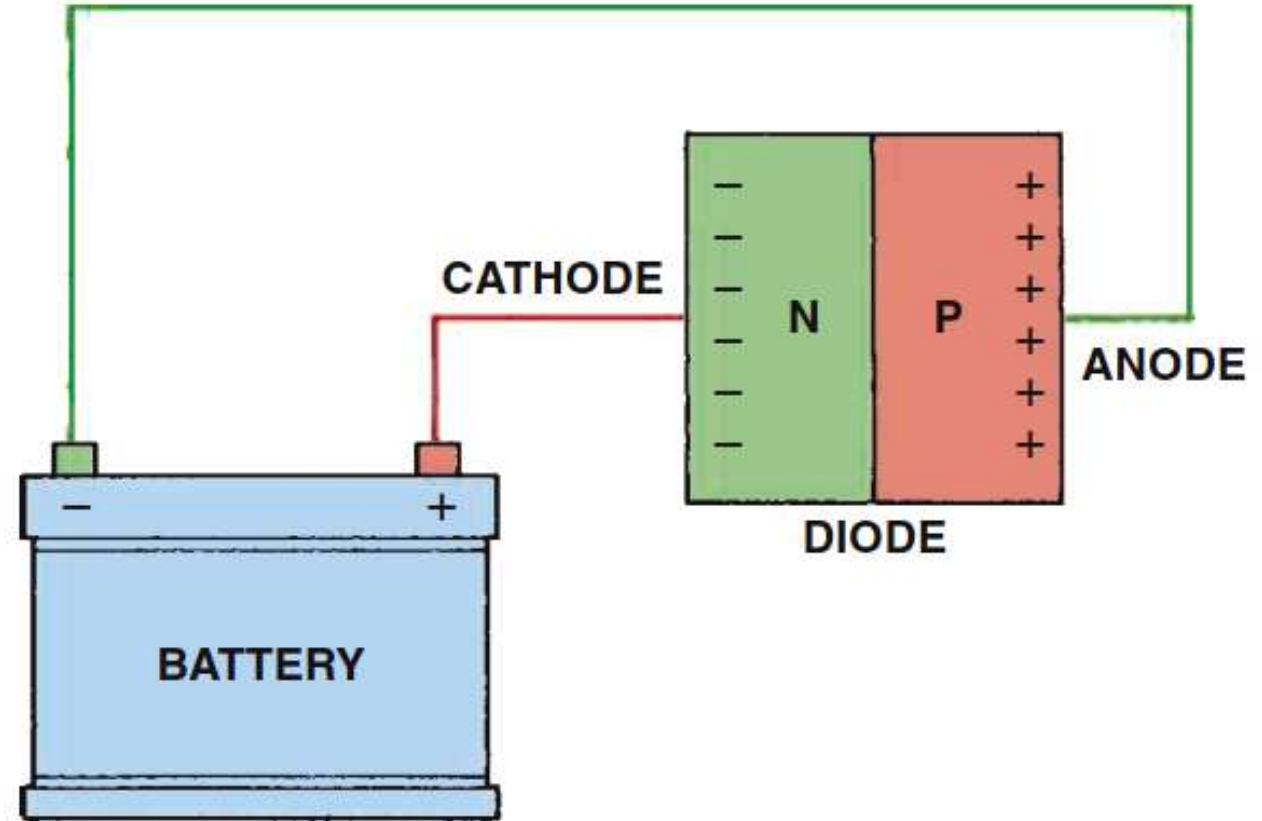


A diode is a component with P-type and N-type materials together





Diode connected to a battery with correct polarity (battery positive to P type and battery negative to N type). Current flows through the diode. This condition is called forward bias.

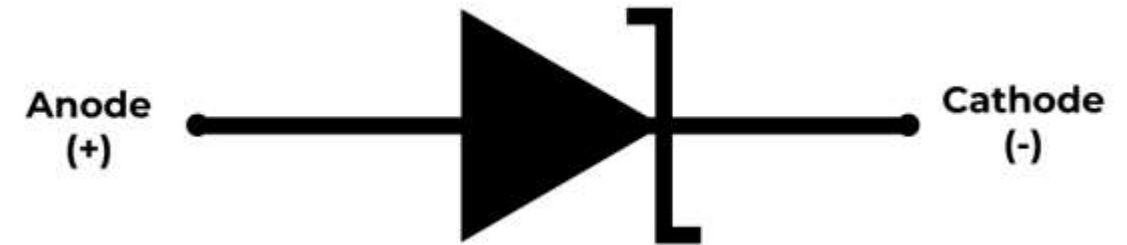


Diode connected with reversed polarity. No current flows across the junction between the P-type and N-type materials. This condition is called reverse bias.

Zener Diodes



A zener diode blocks current flow until a certain voltage is reached, then it permits current to flow.



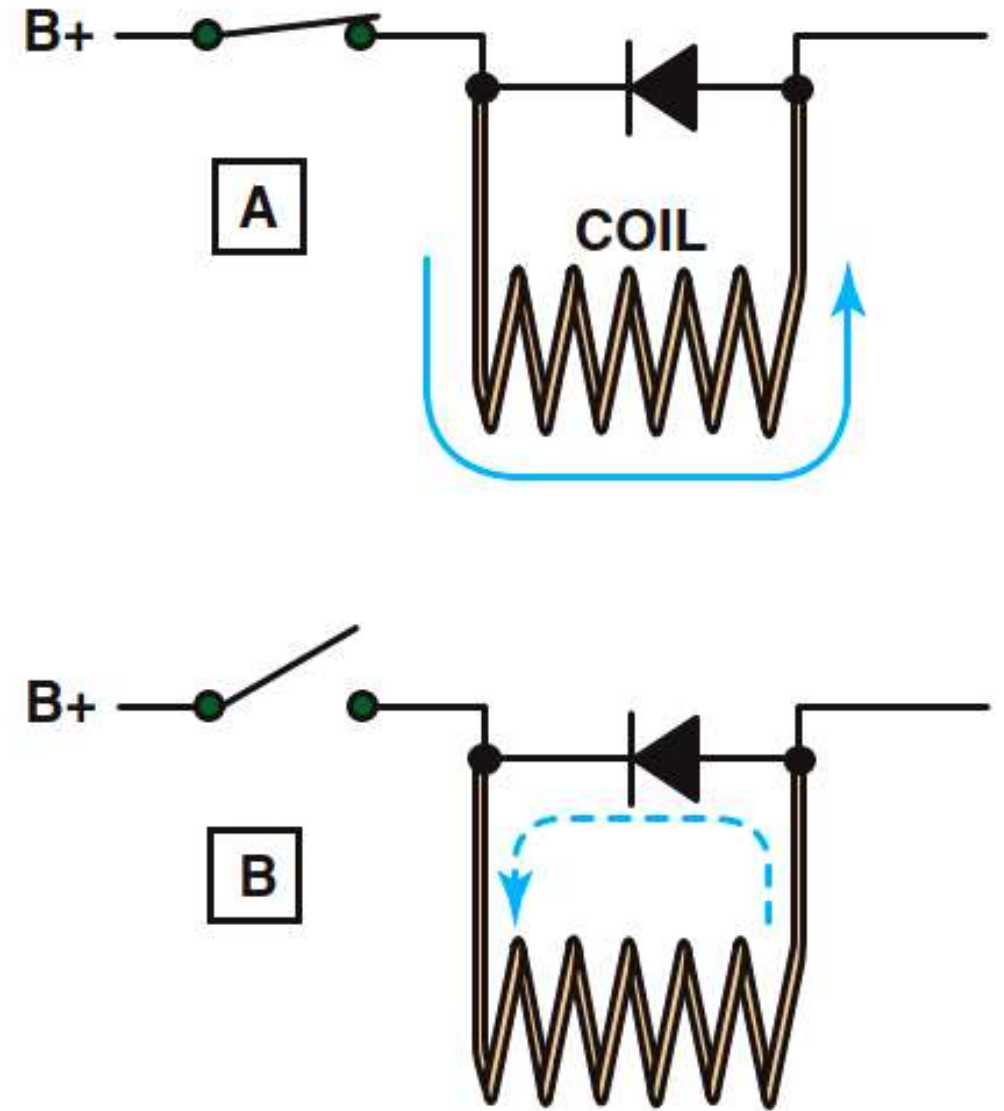
High Voltage Spike Protection

- A clamp diode is where both characteristics of being applied in a circuit to manipulate the input voltage. Clamping diodes can function as a level shifter or can be used to guard components against transient voltages.

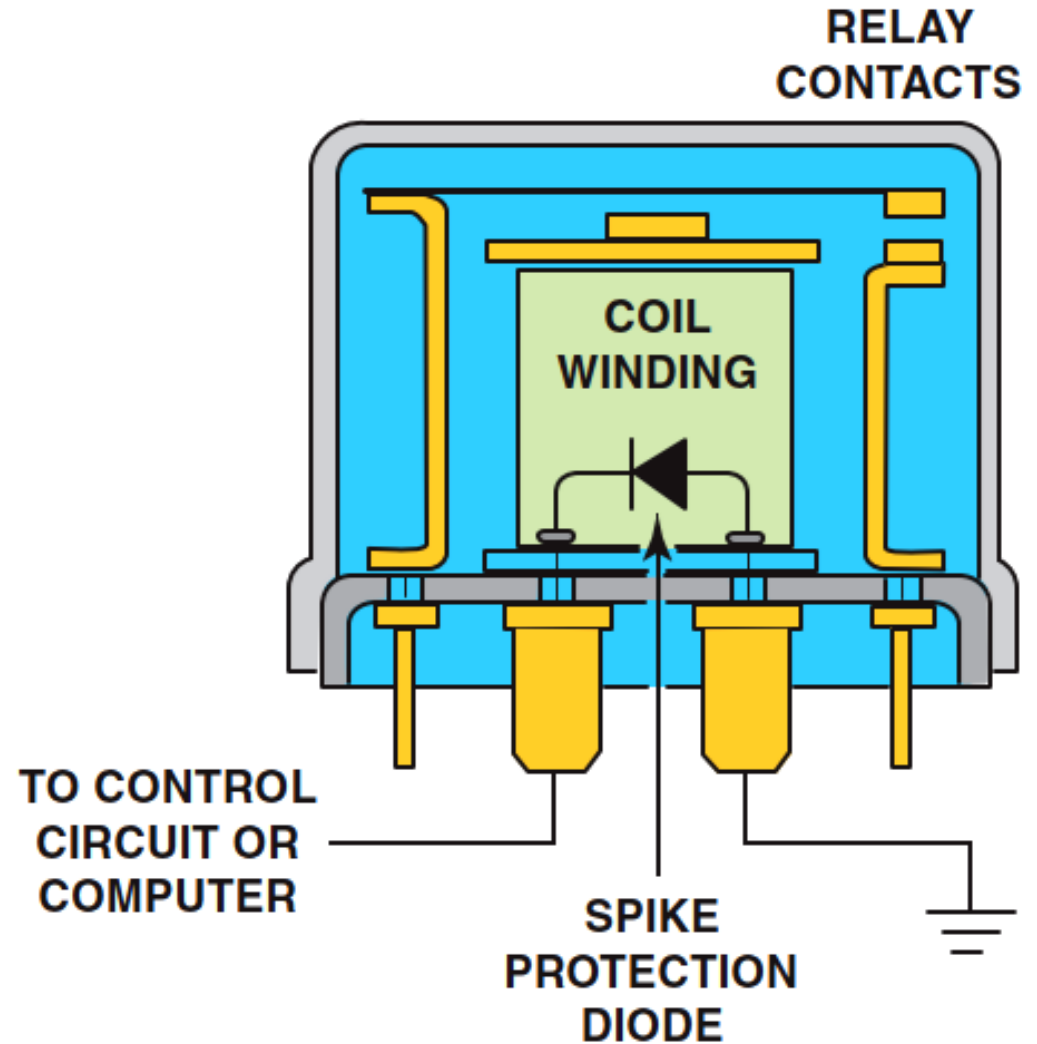


(a) Notice that when the coil is being energized, the diode is reverse biased and the current is blocked from passing through the diode. The current flows through the coil in the normal direction.

- (b) When the switch is opened, the magnetic field surrounding the coil collapses, producing a high-voltage surge in the reverse polarity of the applied voltage. This voltage surge forward biases the diode, and the surge is dissipated harmlessly back through the windings of the coil.

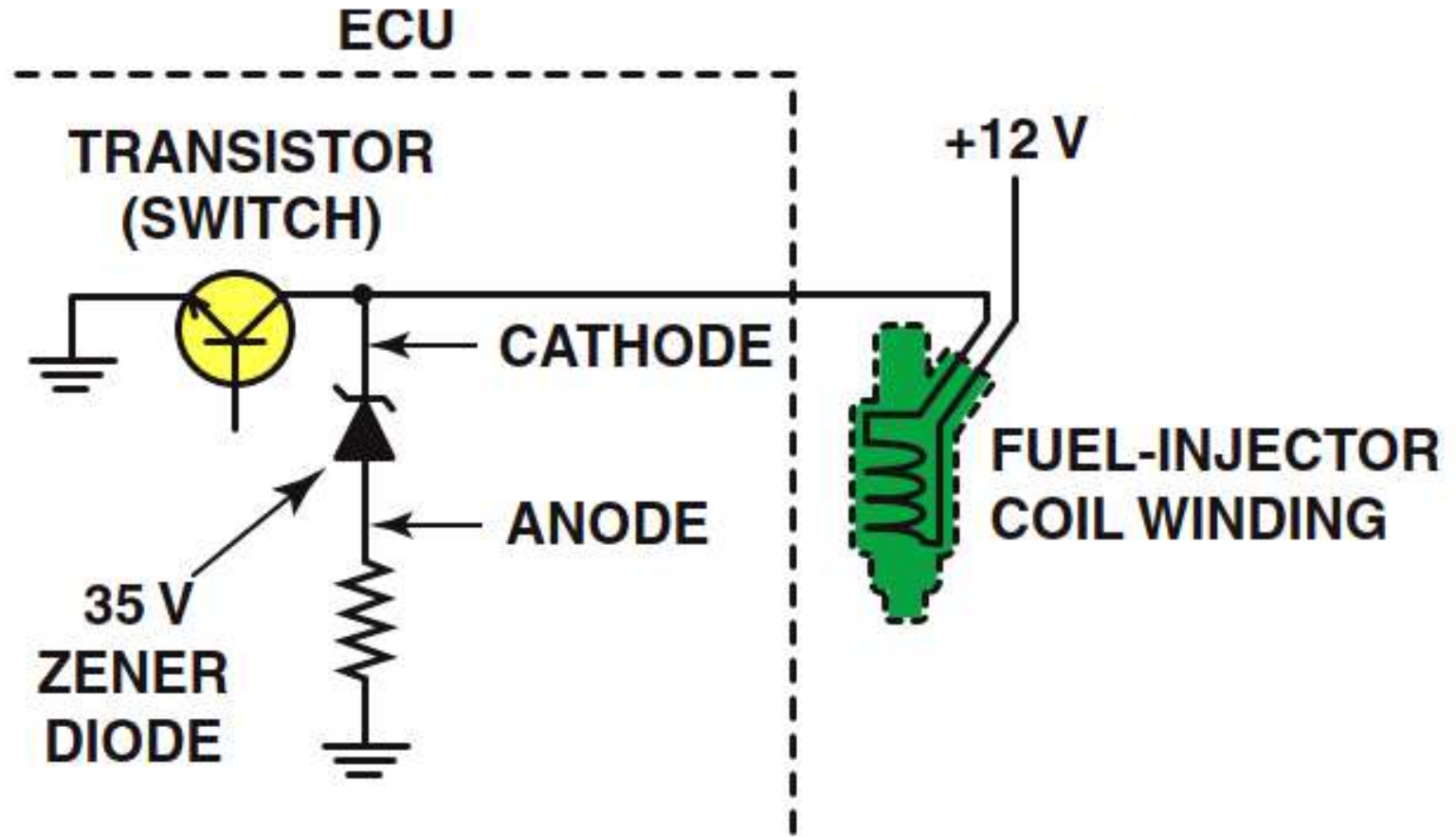


Spike protection diodes are commonly used in computer-controlled circuits to prevent damaging high-voltage surges that occur any time current flowing through a coil is stopped.

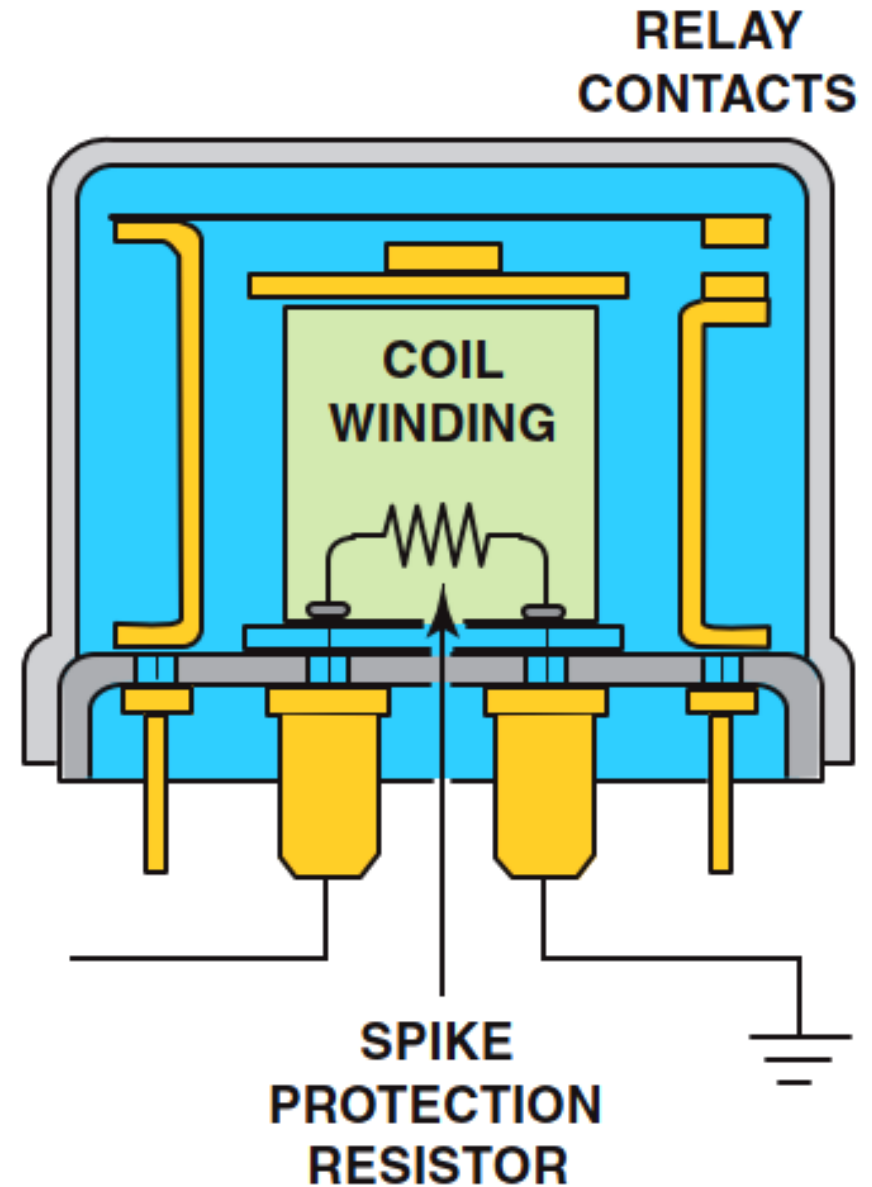
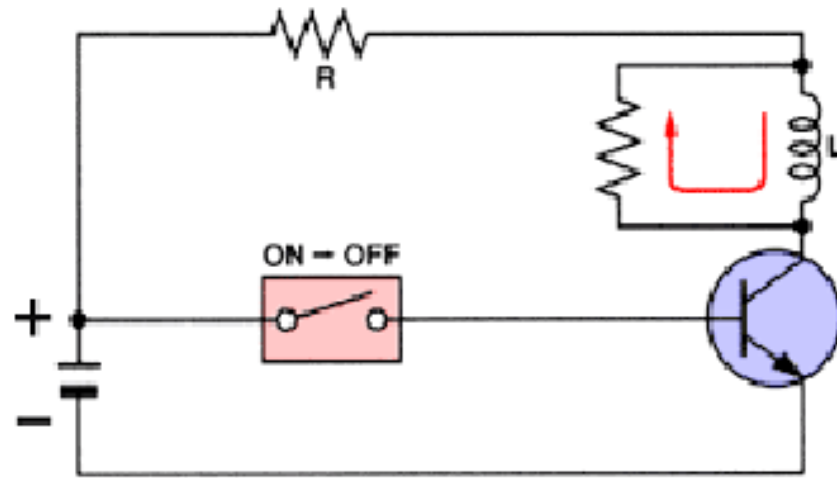


Despiking Zener Diodes

A zener diode is commonly used inside IC to protect delicate electronic circuits from high-voltage spikes.



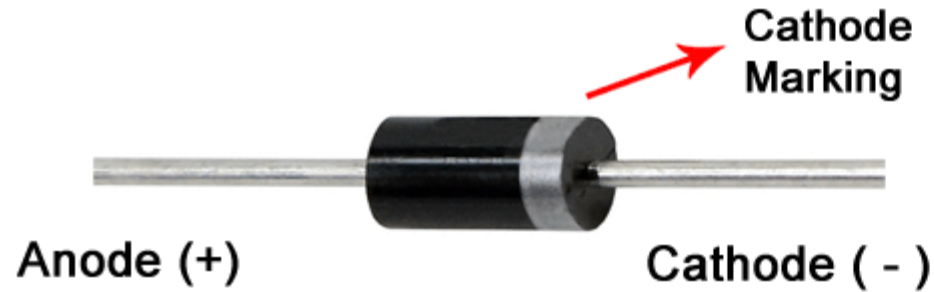
Despiking Resistors



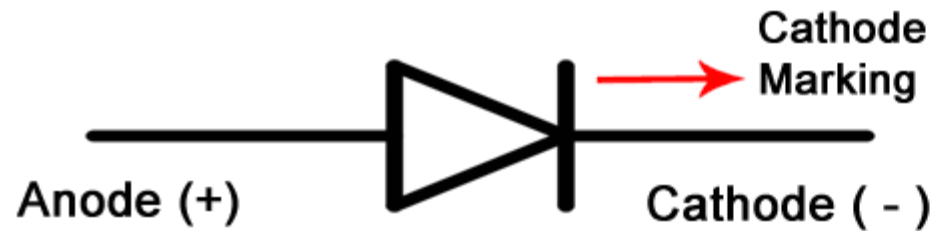
A despiking resistor is used in many applications to help prevent harmful high-voltage surges from being created when the magnetic field surrounding a coil collapses when the coil circuit is opened.

Diode Ratings

1N4001 Diode



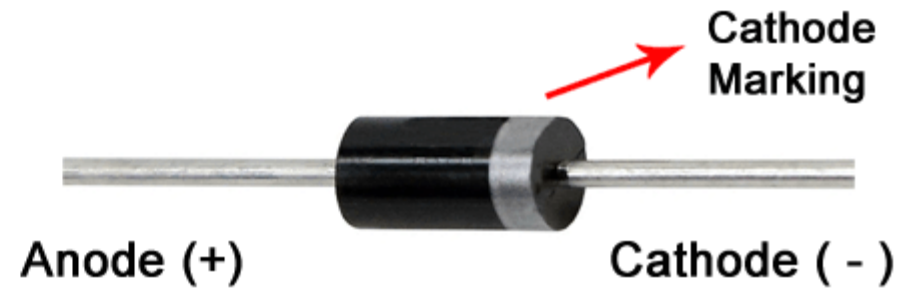
1N4001 Diode Electronic Symbol



Maximum Ratings & Characteristics

- Peak Repetitive Reverse Voltage: 50V
- Peak Non Repetitive Reverse Voltage: 60V
- Max RMS Reverse Voltage: 35V
- Max DC Blocking Voltage: 50V

1N4007 Diode



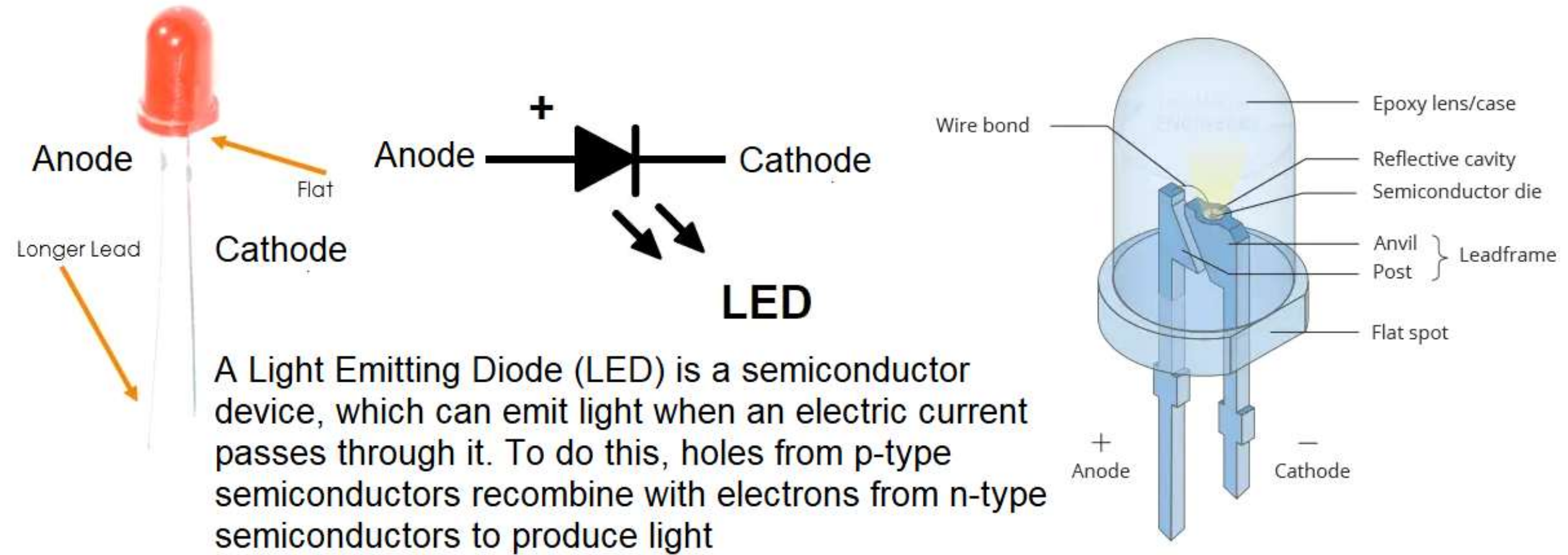
1N4007 Diode Electronic Symbol



Maximum Ratings & Characteristics

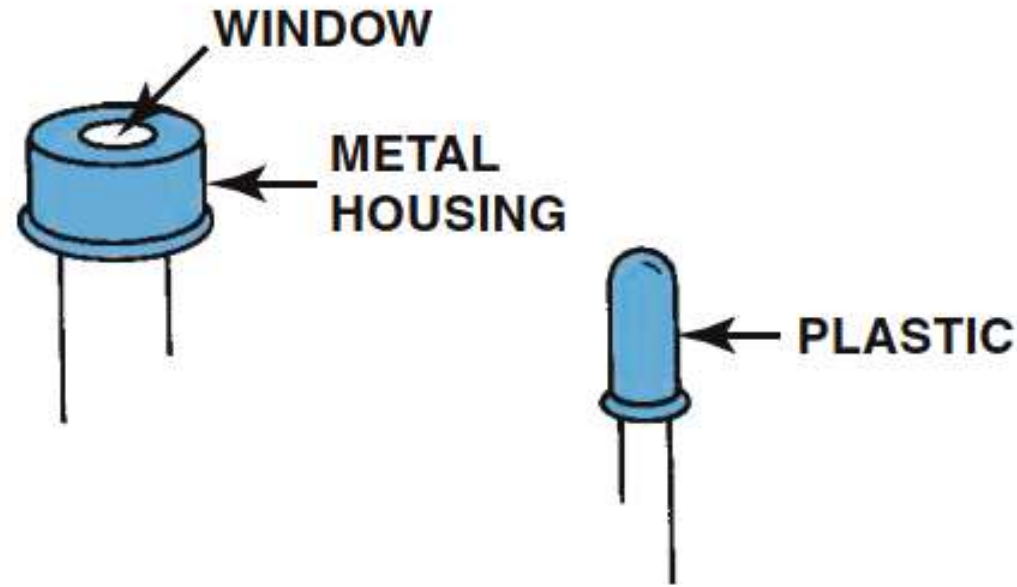
- Peak Repetitive Reverse Voltage: 1000V
- Peak Non Repetitive Reverse Voltage: 1200V
- Max RMS Reverse Voltage: 700V
- Max DC Blocking Voltage: 1000V

Light-emitting diodes (Led)

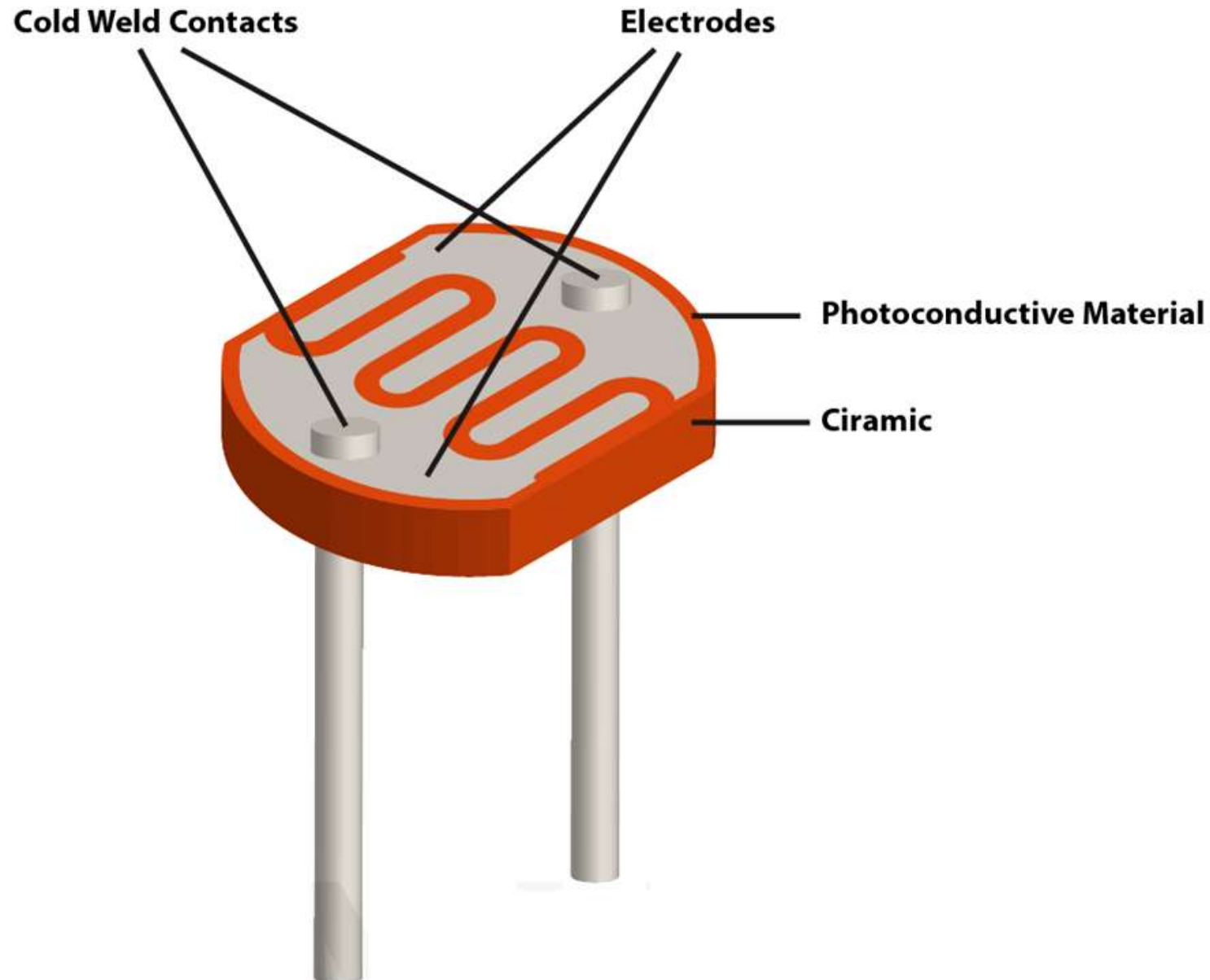


Photodiodes

A photodiode is a semiconductor device with a P-N junction that converts photons (or light) into electrical current.



Photoresistors

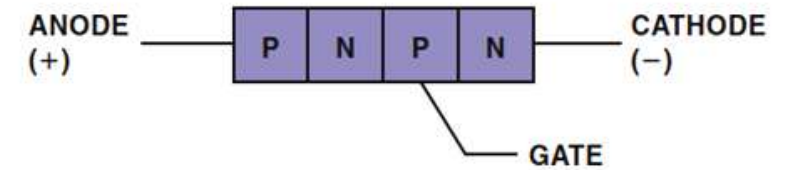
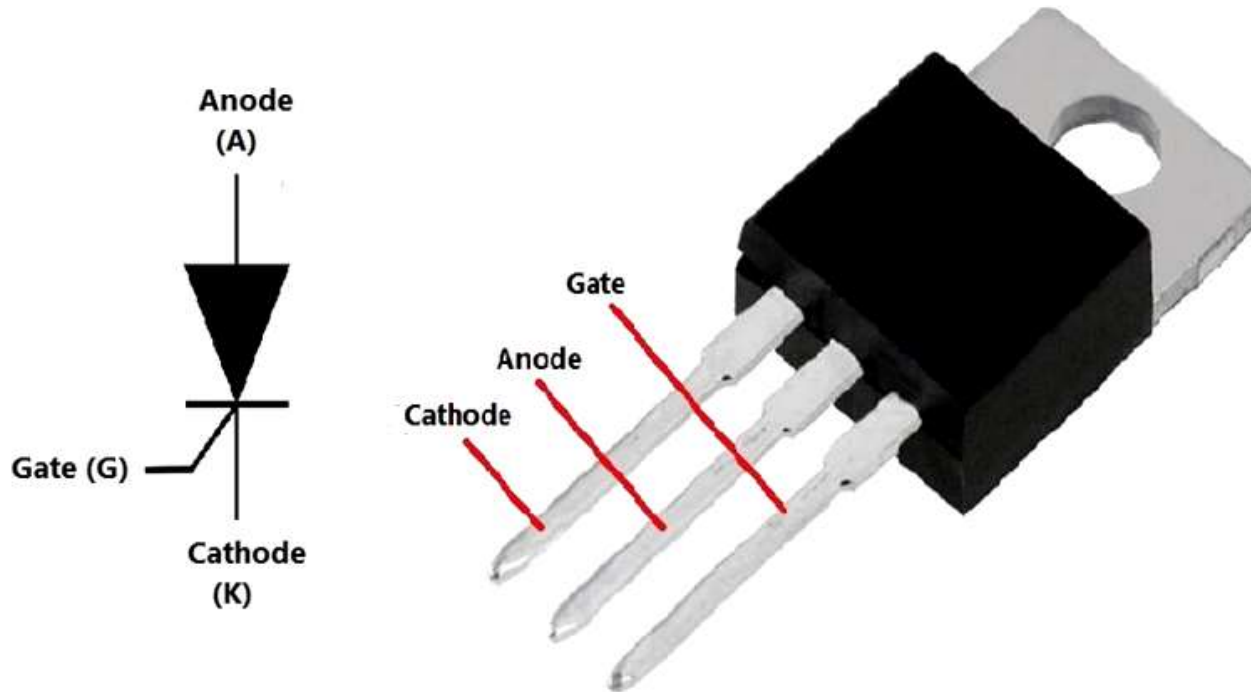


Photoresistors, also known as LDR (light-dependent resistors), are components made of semiconductors.

A photoresistor is sensitive to light. Its resistance decreases when lighting increases

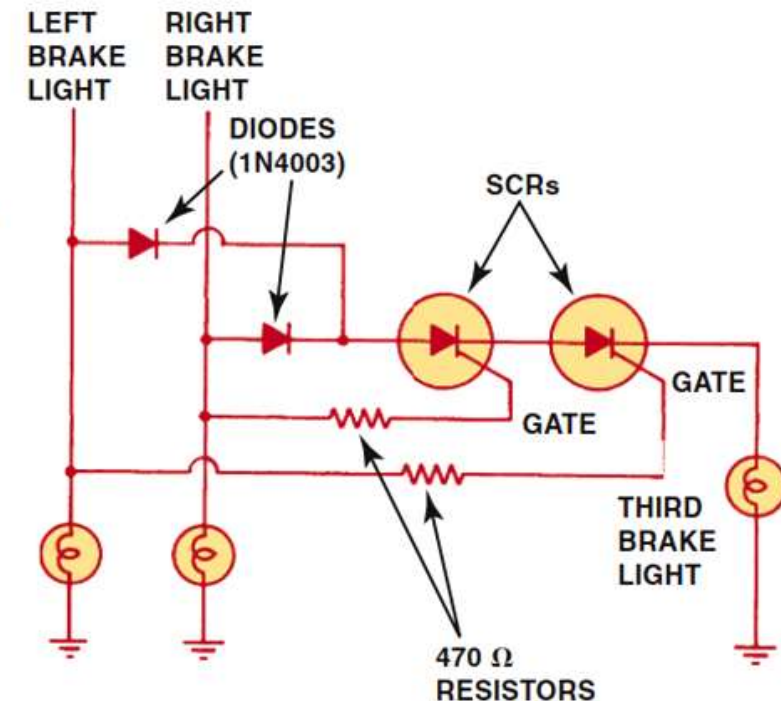
Silicon-Controlled Rectifier (SCR)

A silicon controlled rectifier or semiconductor controlled rectifier is a four-layer solid-state current-controlling device.



Symbol and terminal identification of an SCR.

Wiring diagram for a center high-mounted stoplight (CHMSL) using SCRs.

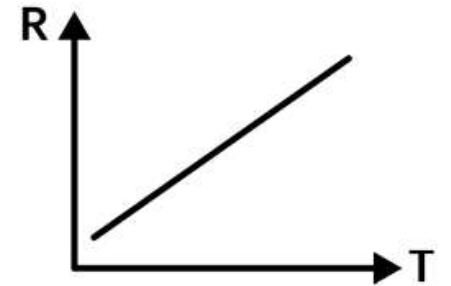
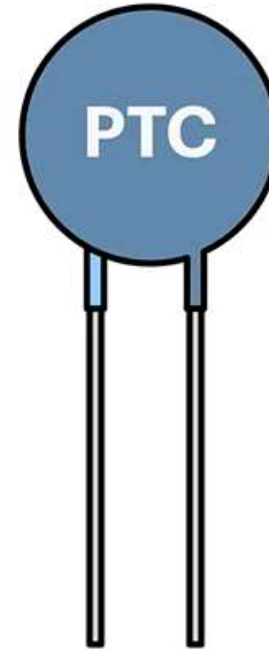
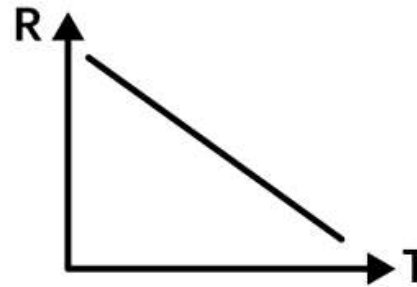
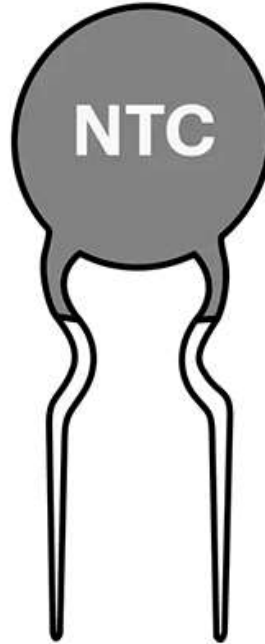
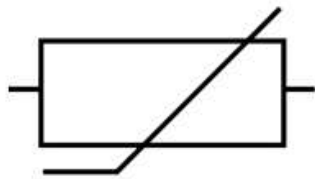


Thermistor

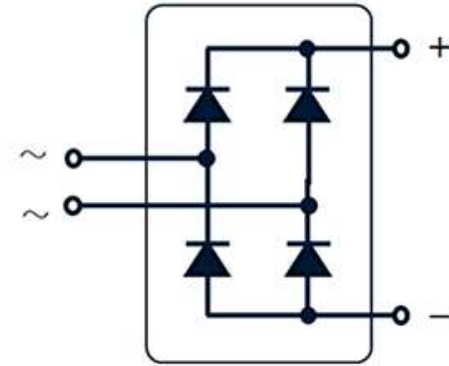
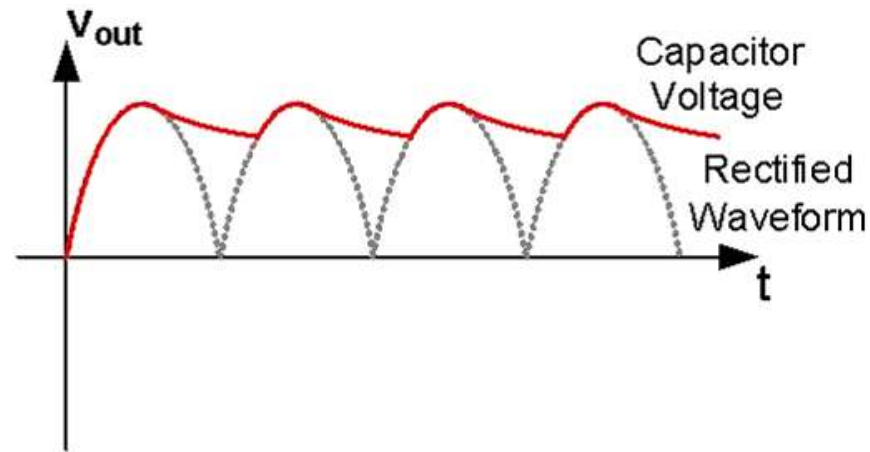
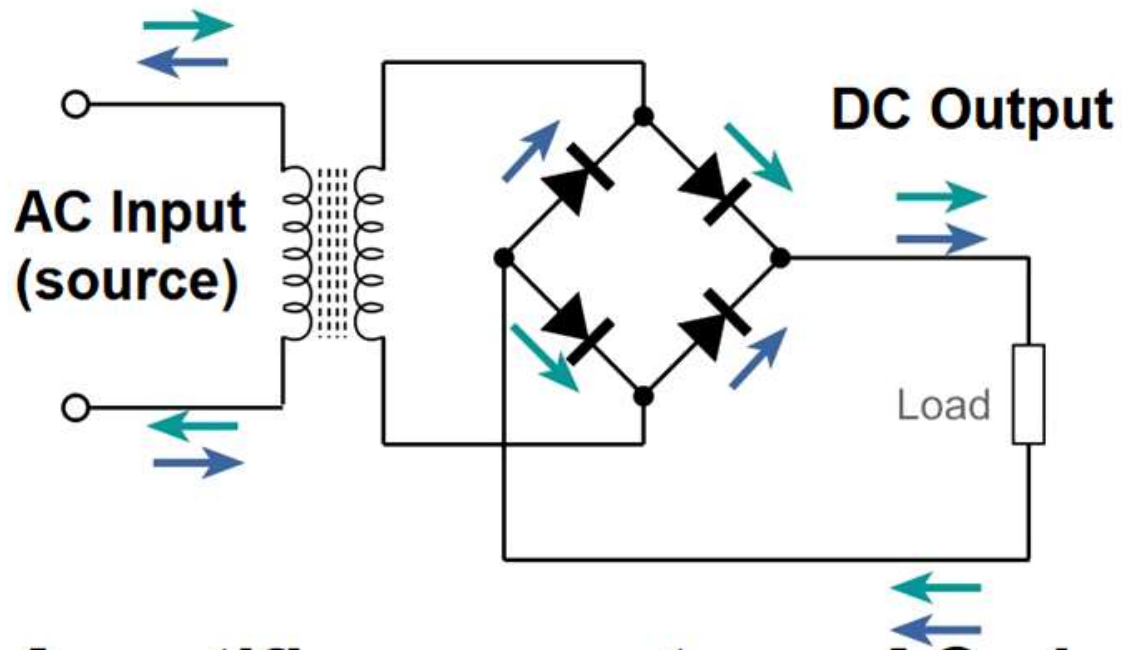
Negative Temperature Coefficient

Positive Temperature Coefficient

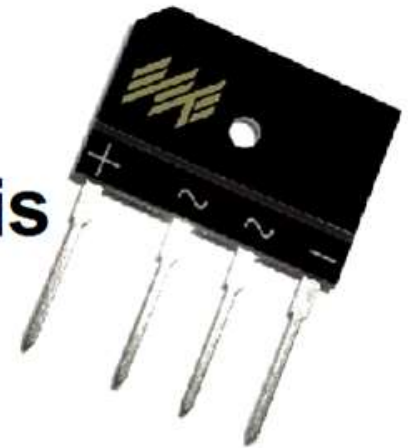
A thermistor is a thermally sensitive resistor that exhibits a precise and predictable change in resistance proportional to small changes in body temperature



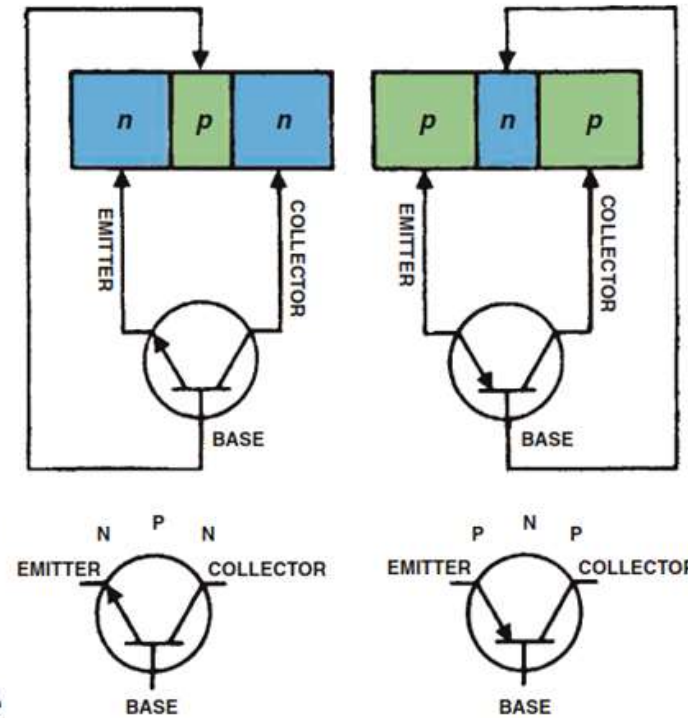
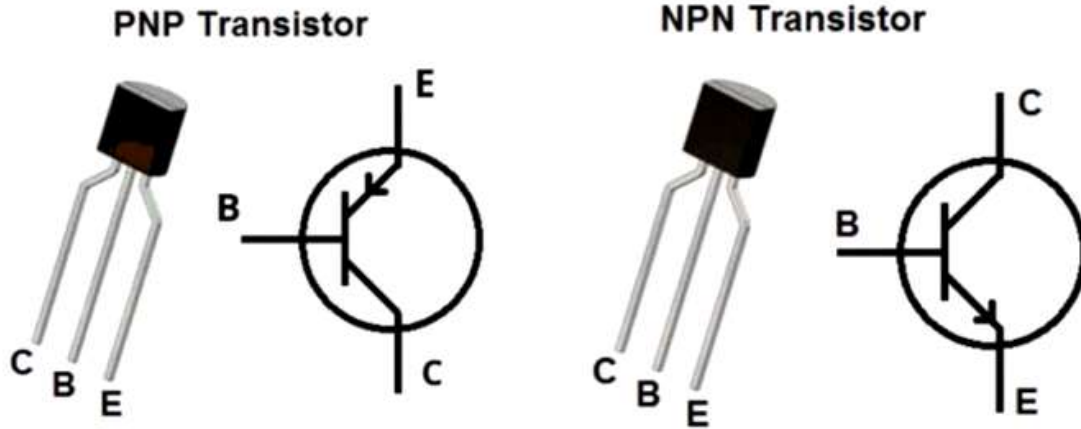
Rectifier Bridge



A rectifier converts an AC signal into DC, and a bridge rectifier does this using a diode bridge. A diode bridge is a system of four or more diodes in a bridge circuit configuration, A bridge rectifier provides full-wave rectification.

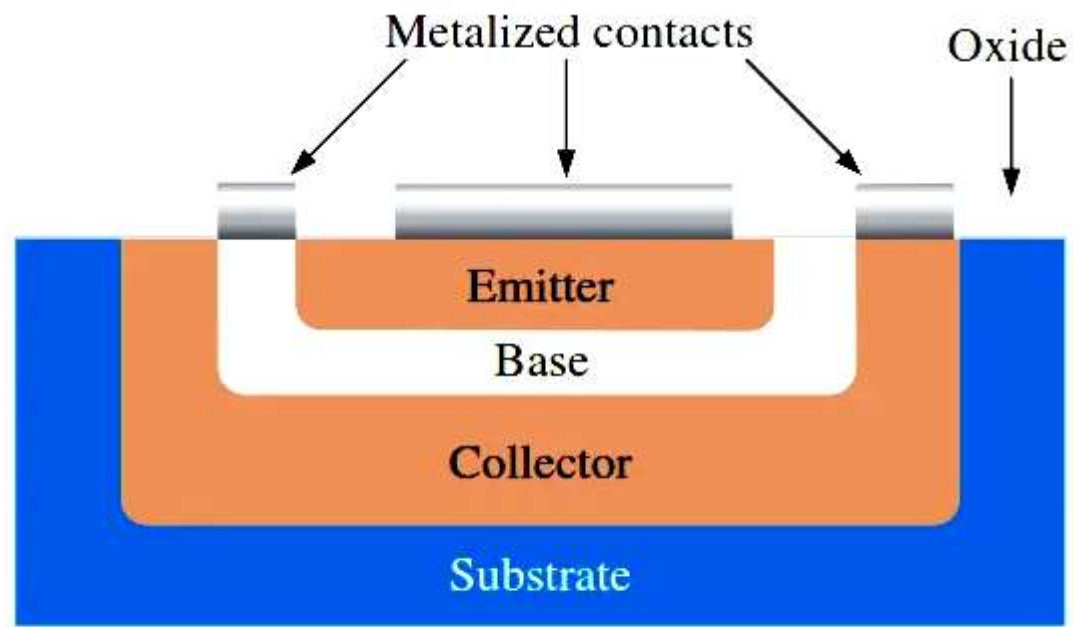


Transistor



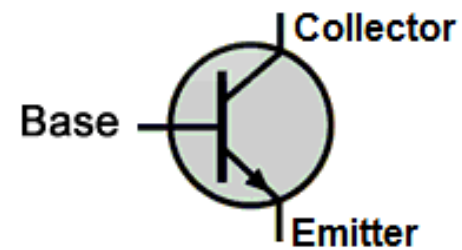
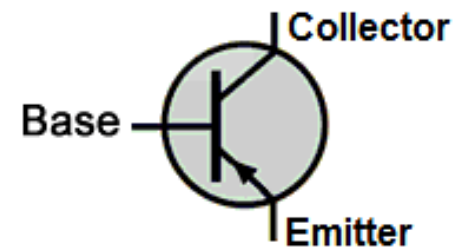
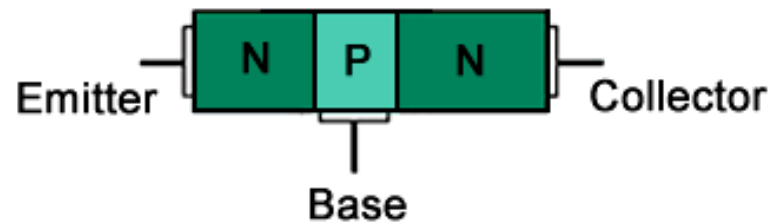
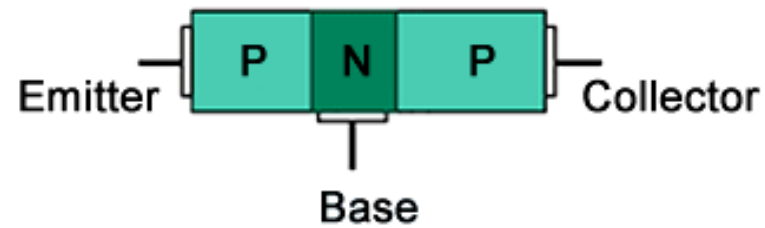
Basic transistor operation. A small current flowing through the base and emitter of the transistor turns on the transistor and permits a higher amperage current to flow from the collector and the emitter.

A transistor is a semiconductor device used to amplify or switch electronic signals. Transistors are broadly divided into three types: bipolar transistors (bipolar junction transistors: BJTs), field-effect transistors (FETs), and insulated-gate bipolar transistors (IGBTs)

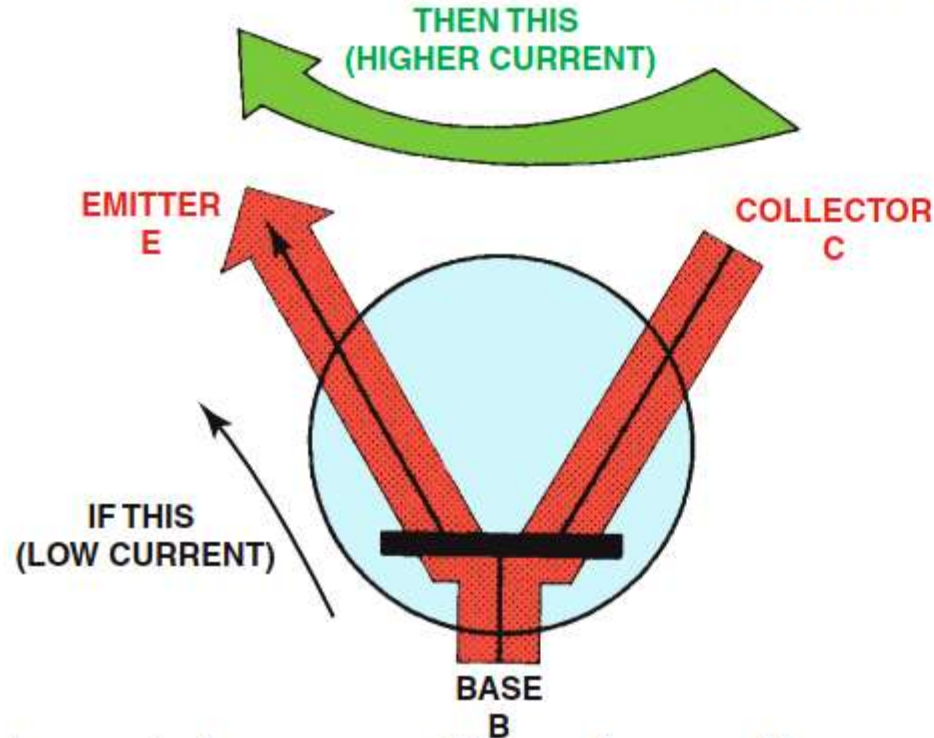


(a) Basic epitaxial planar structure

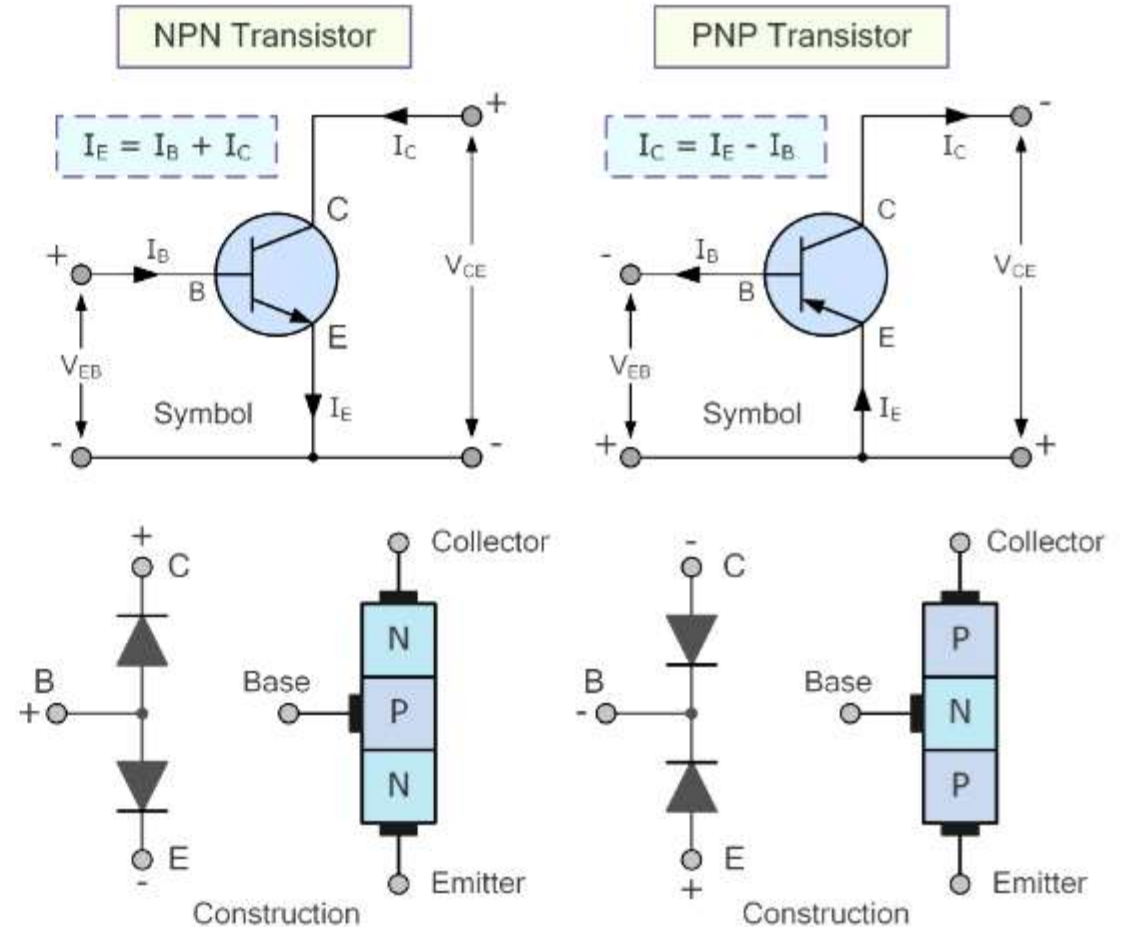
Bipolar Junction Transistor Construction

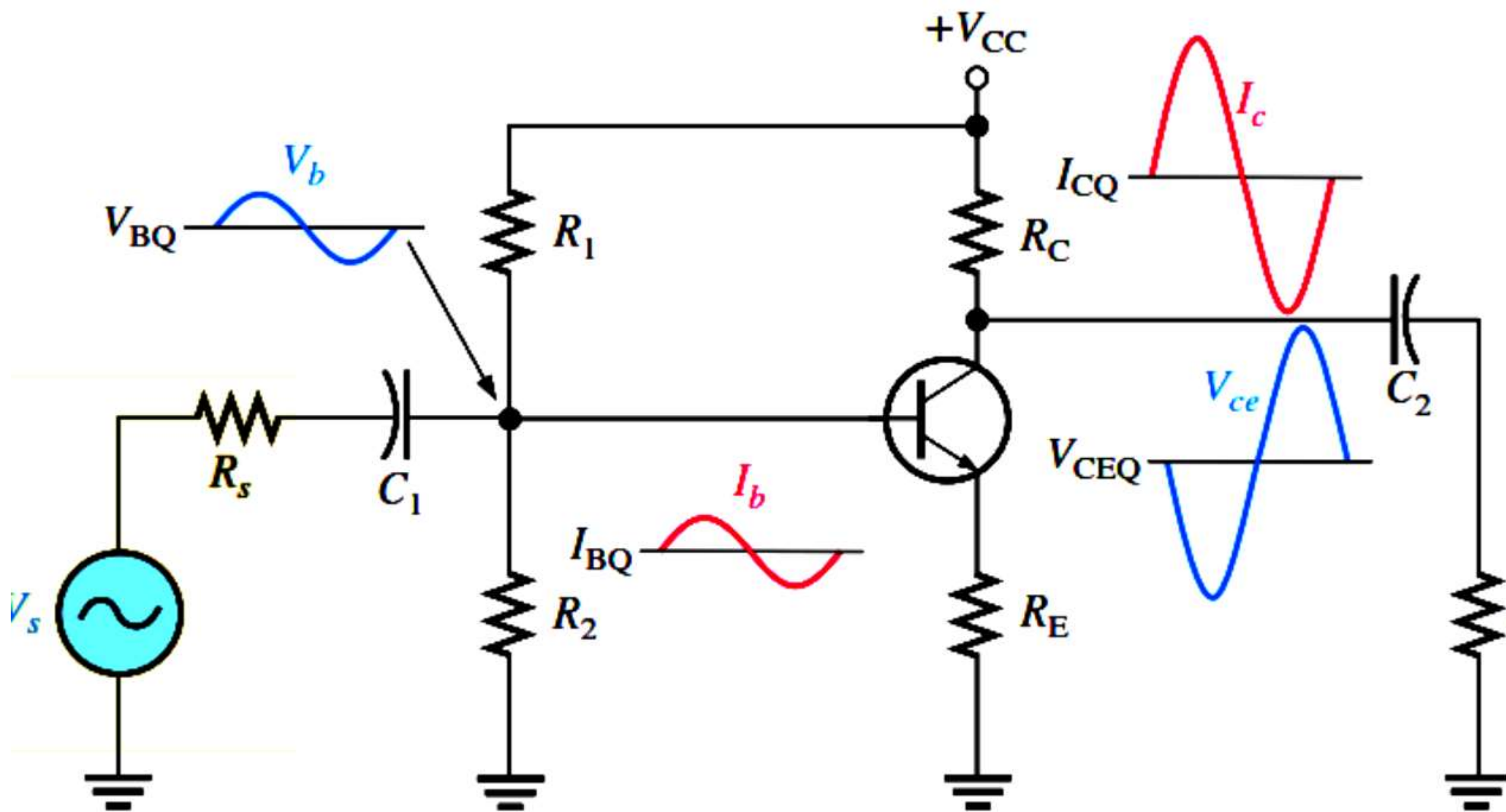


How a Transistor Work



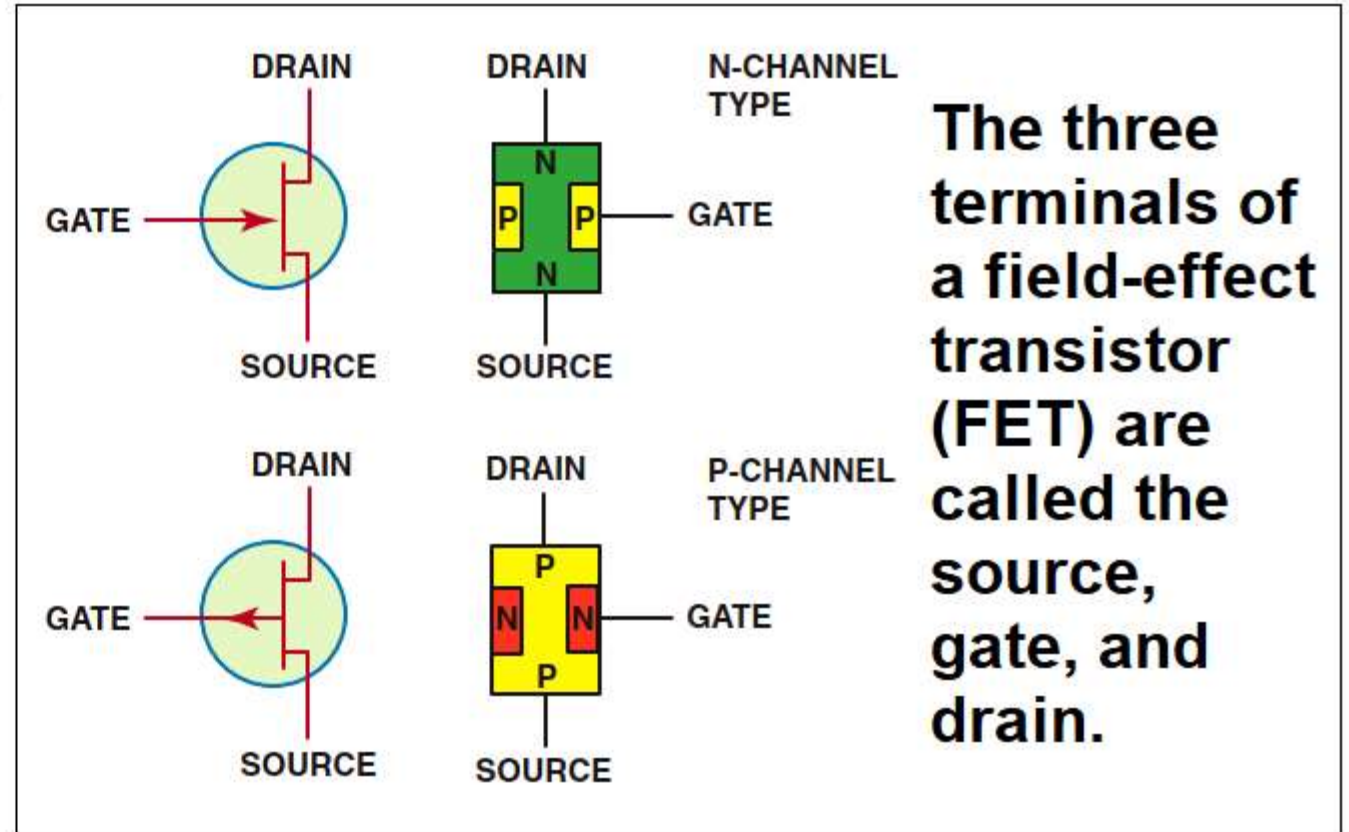
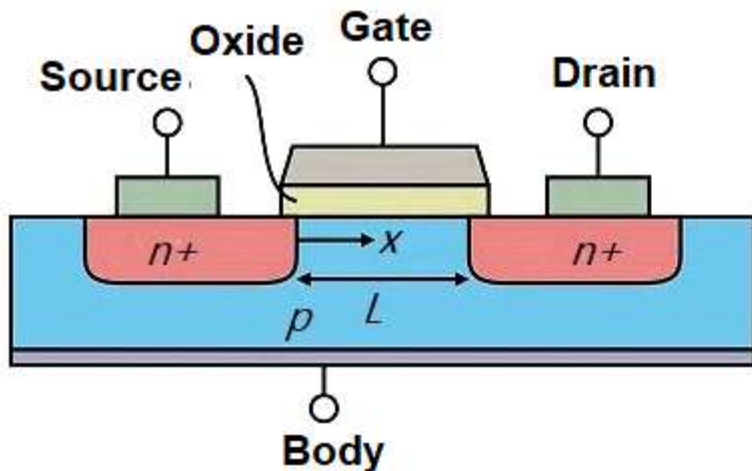
Basic transistor operation. A small current flowing through the base and emitter of the transistor turns on the transistor and permits a higher amperage current to flow from the collector and the emitter.



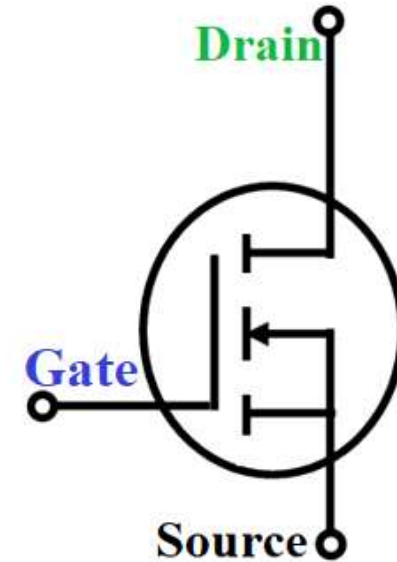
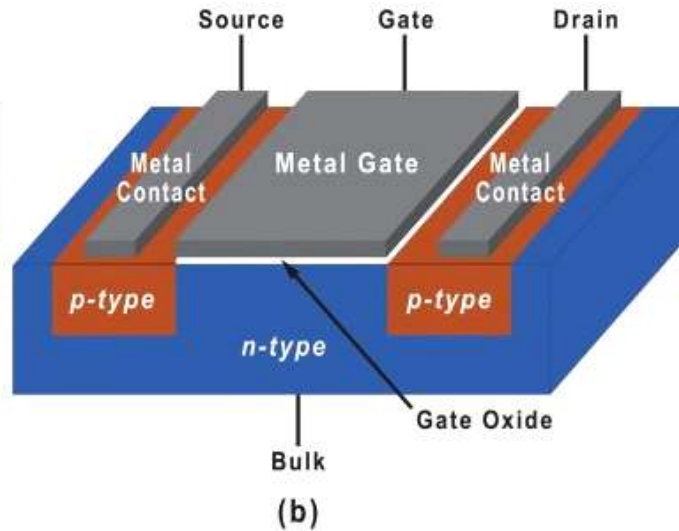
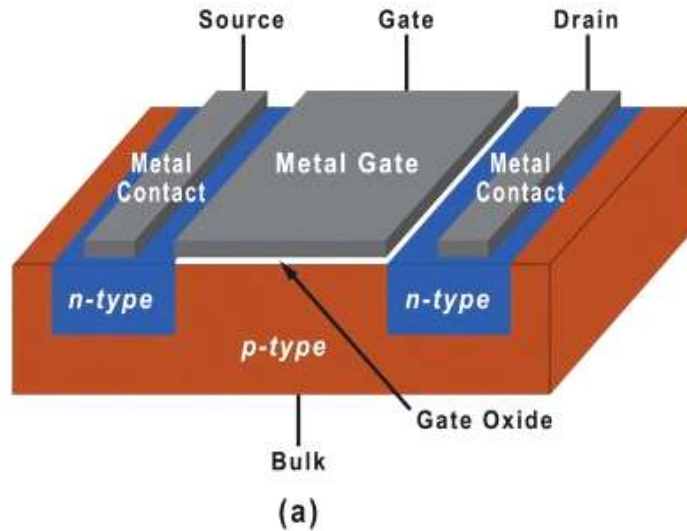


Field-effect transistors (FETs)

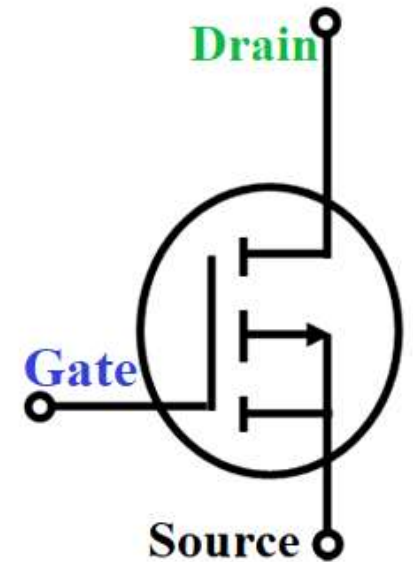
A Field Effect Transistor (FET) is a three-terminal Active semiconductor device, where the output current is controlled by an electric field generated by the input voltage



MOSFET

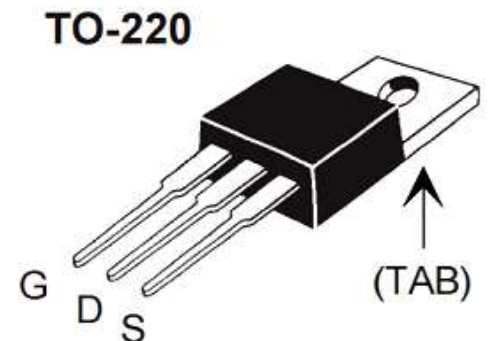
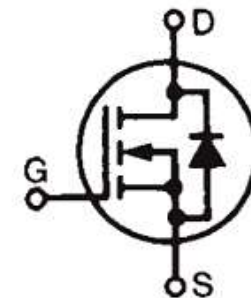


**N-Channel
MOSFET**



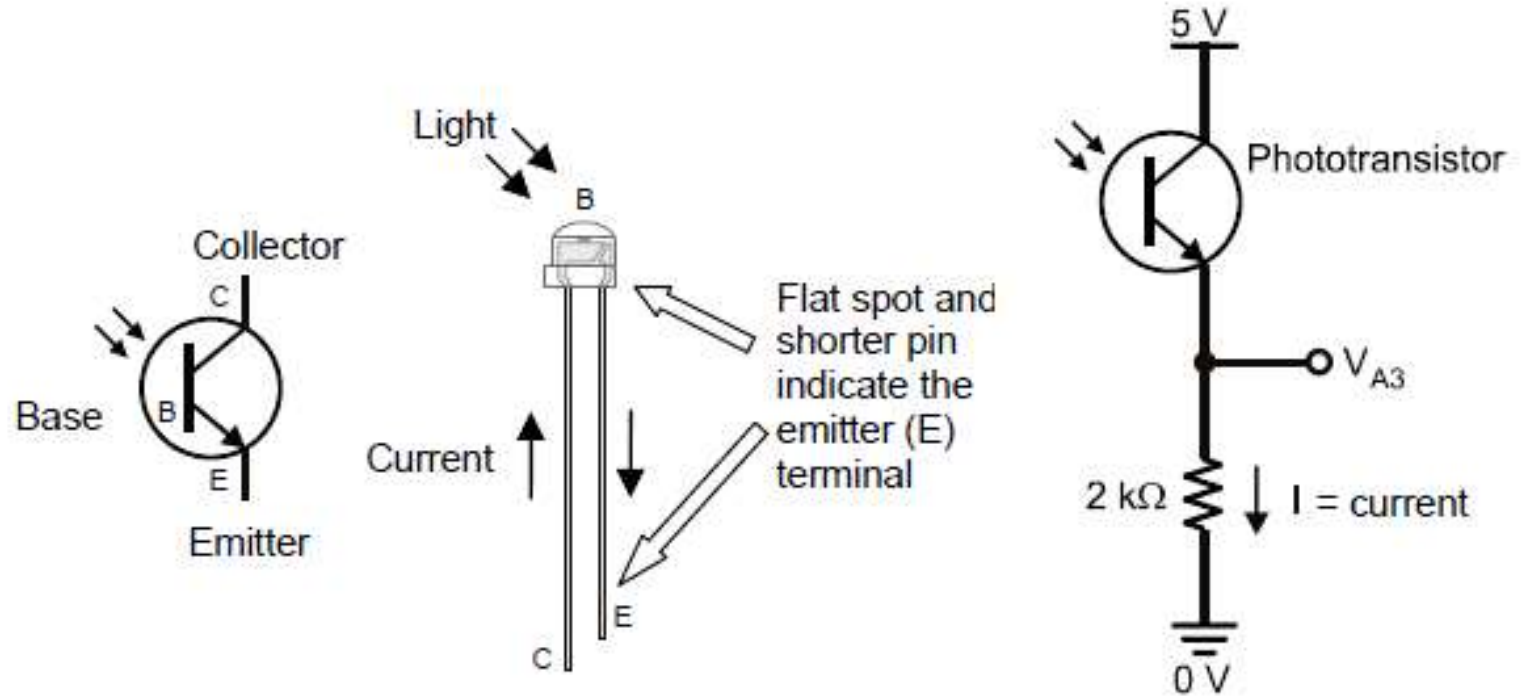
**P-Channel
MOSFET**

The MOSFET is the most common type of transistor today. Their primary use is to control conductivity, or how much electricity can flow, between its source and drain terminals based on the amount of voltage applied to its gate terminal.



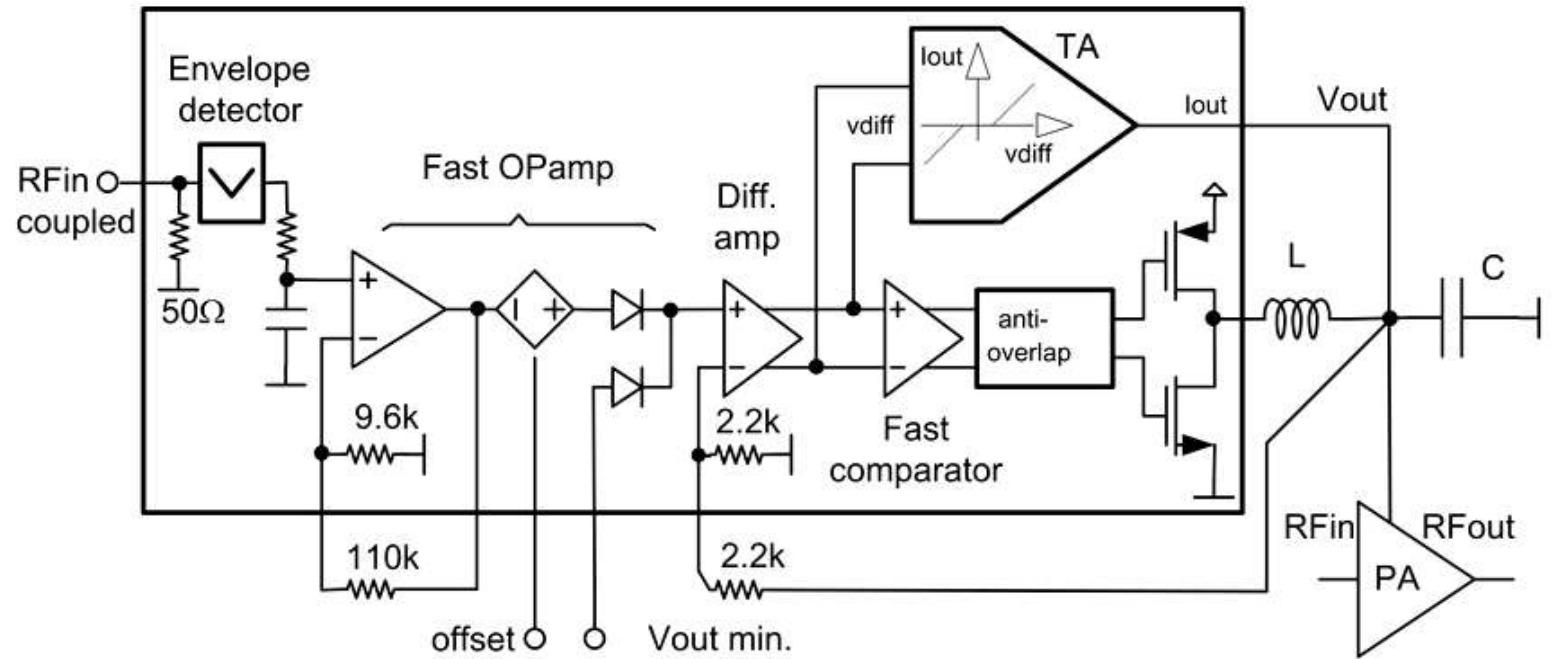
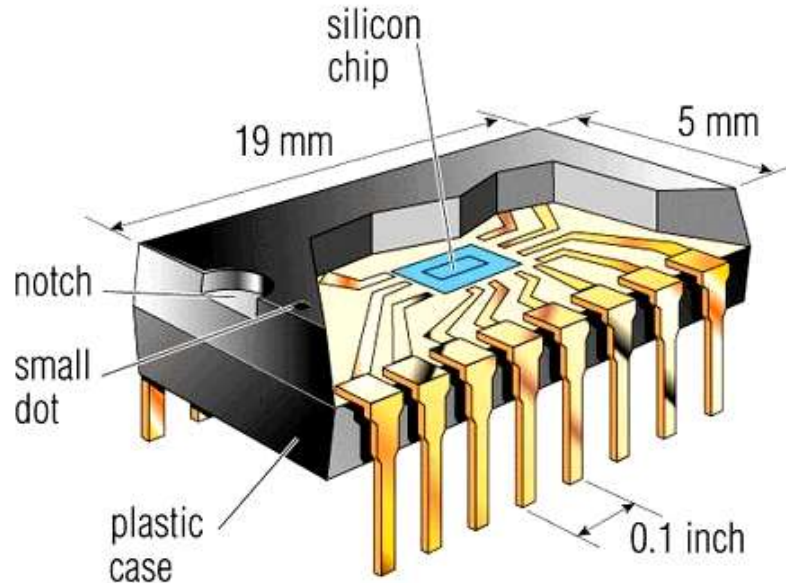
Phototransistor

The phototransistor is a device that operates by converting incoming photons to electrons in the base of a bipolar transistor. As for any such transistor, the base current causes a larger collector-emitter current to flow, which is detected by a circuit



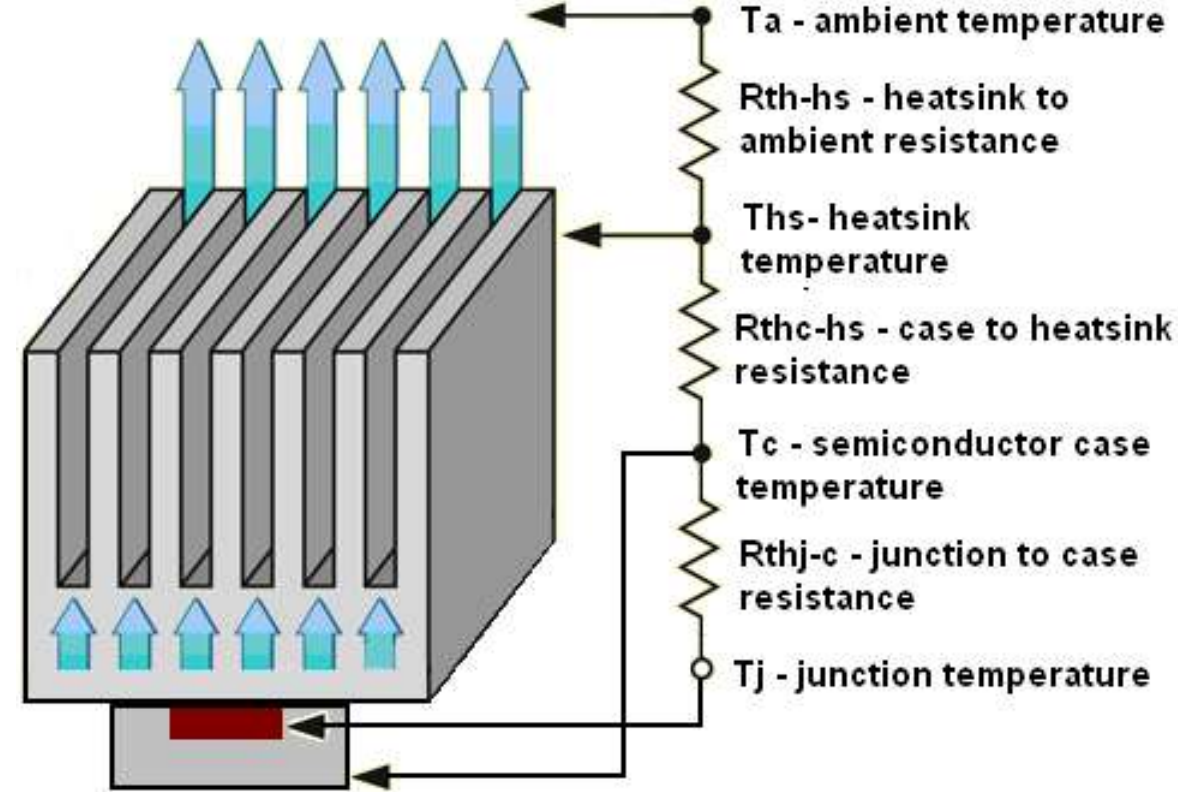
Integrated Circuit (IC)

An integrated circuit (also known as an IC, a chip, or a microchip) is a set of electronic circuits on one small flat piece[a] of semiconductor material, usually silicon. Large numbers of miniaturized transistors and other electronic components are integrated together on the chip.



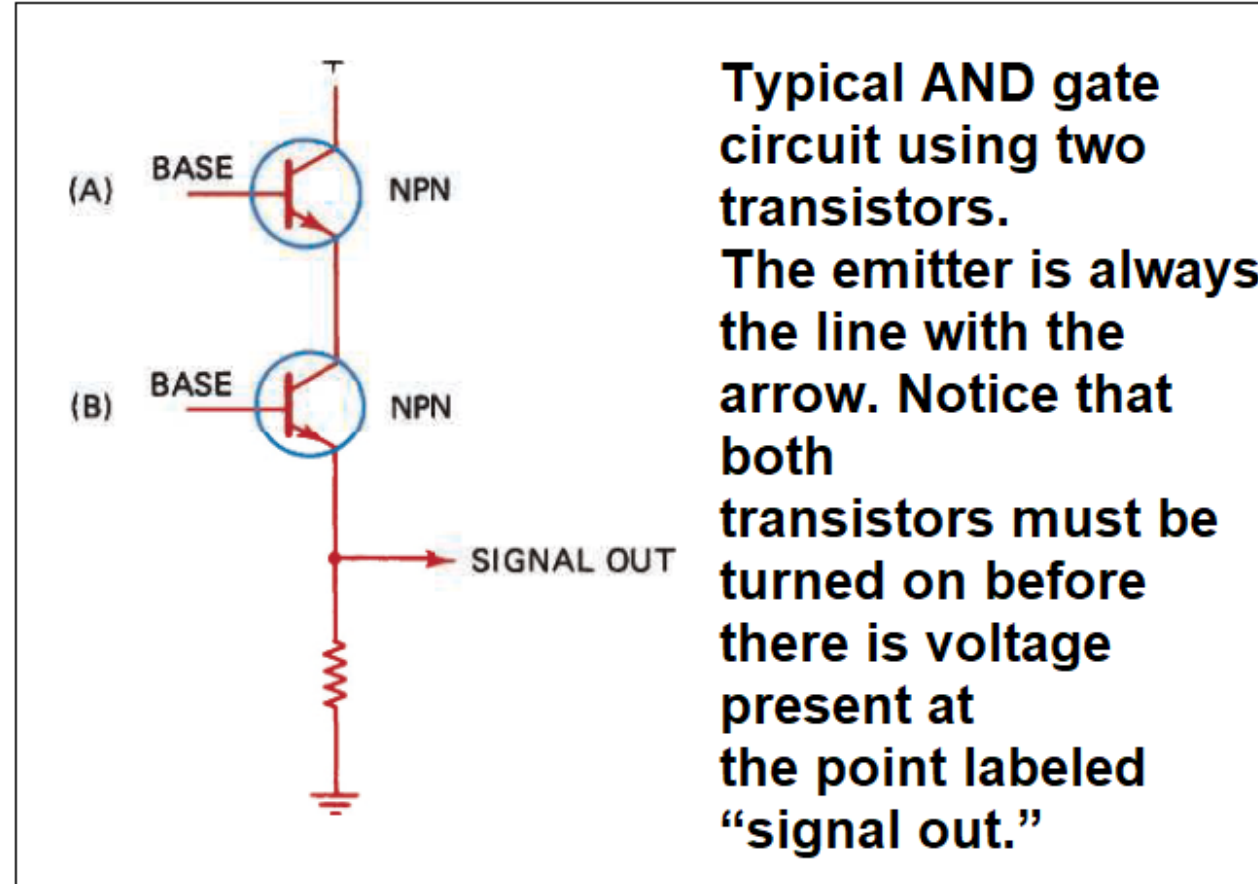
Heat Sink

- A **heat sink** (also commonly spelled **heatsink**) is a passive heat exchanger that transfers the heat generated by an electronic. A heat sink is designed to maximize its surface area in contact with the cooling medium surrounding it, such as the air.

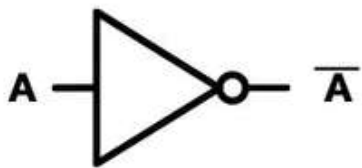




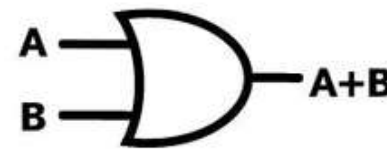
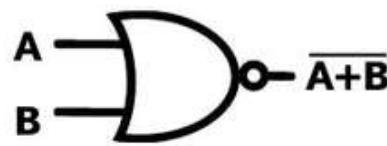
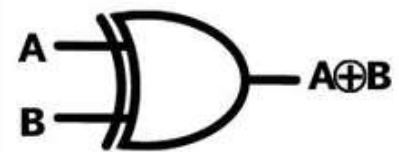
Transistor Gate

Transistors make up the basic fabric of a chip. All transistors are interconnected and act as switches for electrical current. These gates turn on and off, either allowing or preventing current from passing through. This means that each transistor can be in two different states, storing two numbers – zero and one. With billions of transistors, a chip can contain billions of zeros and ones, sending, receiving and processing a remarkable amount of digital data.



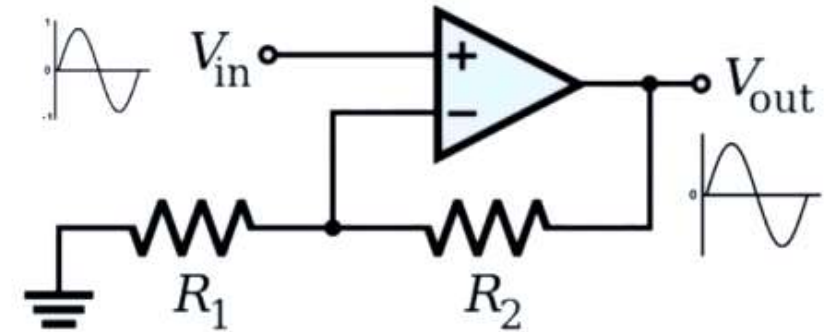
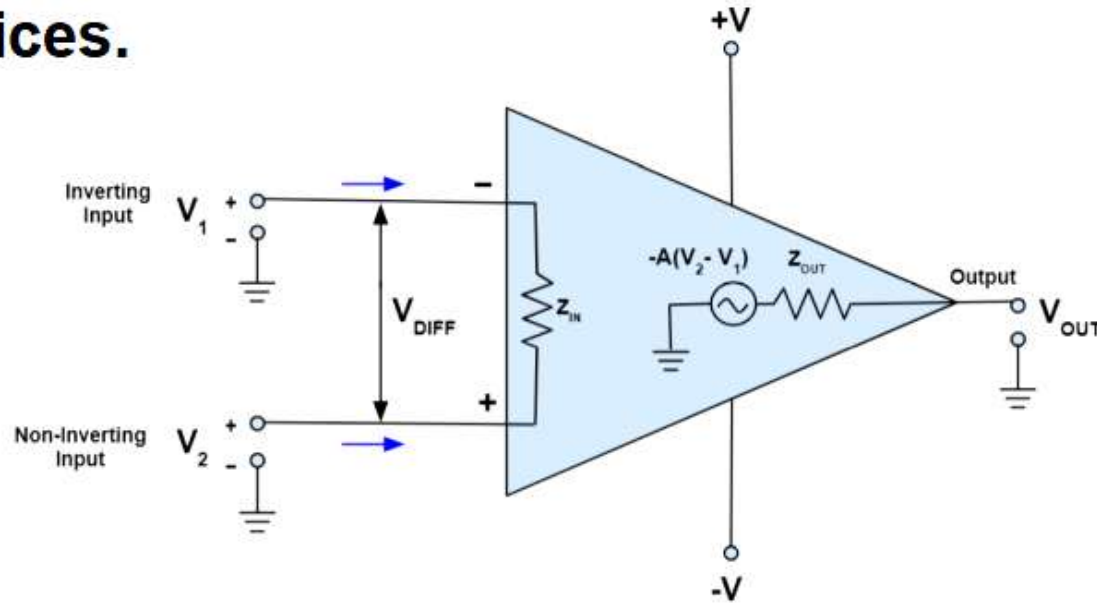
THE ROLE OF THE LOGIC GATE | DEMYSTIFYING DIGITAL ELECTRONICS

Name	Symbol & notation	Explanation
NOT		<p>The inverter</p> <p>NOT simply accepts an input and outputs the opposite.</p>
AND		<p>All inputs must be positive (1) before the output is positive (1 or ON)</p>
NAND <small>*Not AND</small>		<p>Same as AND, but the outcome is the inverse (NOT).</p> <p>So, perform AND first, then apply NOT to the output.</p>

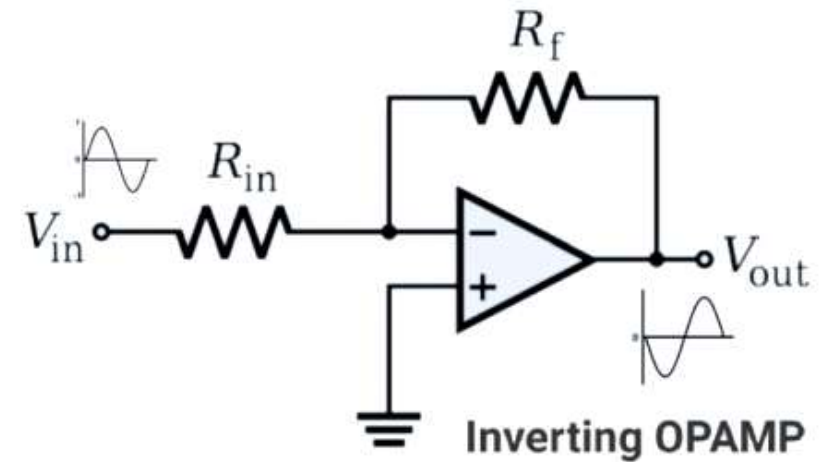
OR		<p>At least one input must be positive (1) to give a positive output (1 or ON).</p> <p>All inputs could also be positive.</p>
NOR <small>*Not OR</small>		<p>Same as OR, but the outcome is the inverse (NOT).</p> <p>So, perform OR first, then apply NOT to the output.</p>
XOR <small>*eXclusive OR</small>		<p>Only one input can be positive (1) to give a positive output (1 or ON).</p> <p>If both are positive, the output is negative (0 or OFF)</p>

Operational Amplifier (Op-amp)

Operational Amplifiers, also known as Op-amps, are basically a voltage amplifying device designed to be used with components like capacitors and resistors, between its in/out terminals. They are essentially a core part of analog devices.

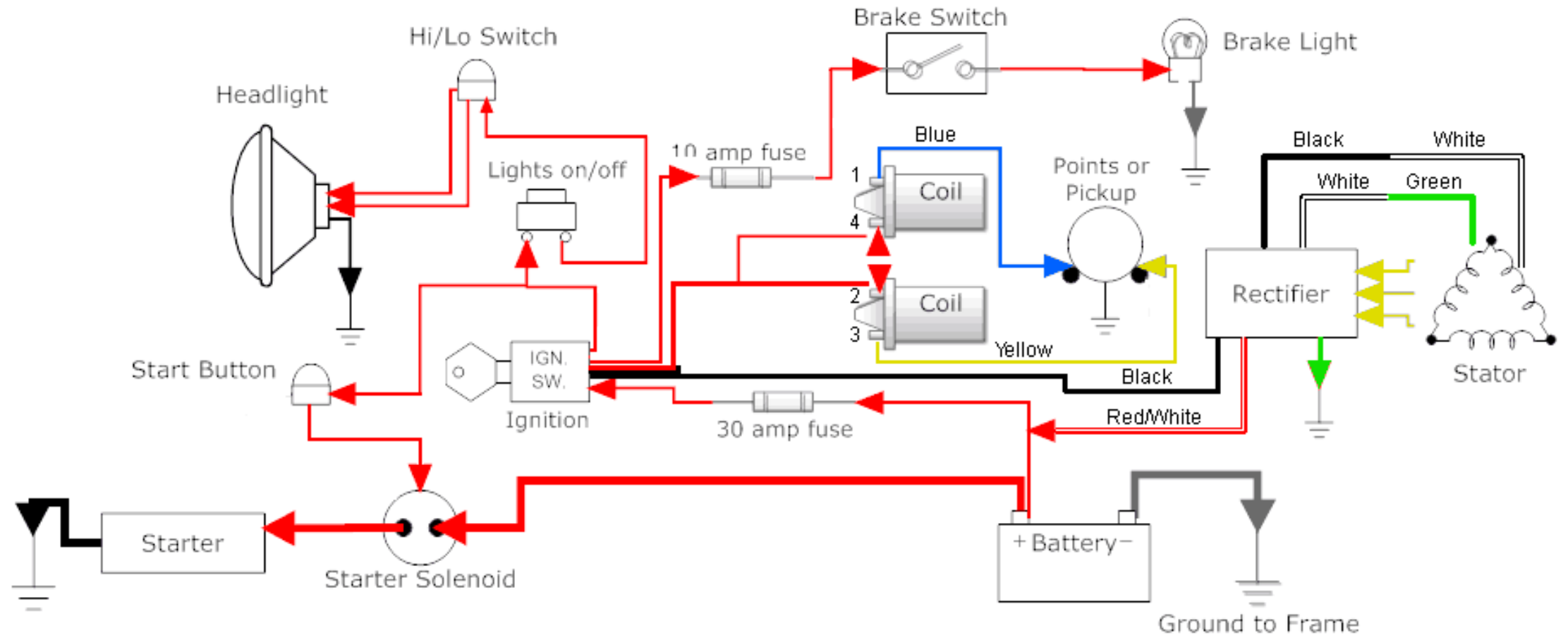


Non Inverting OPAMP

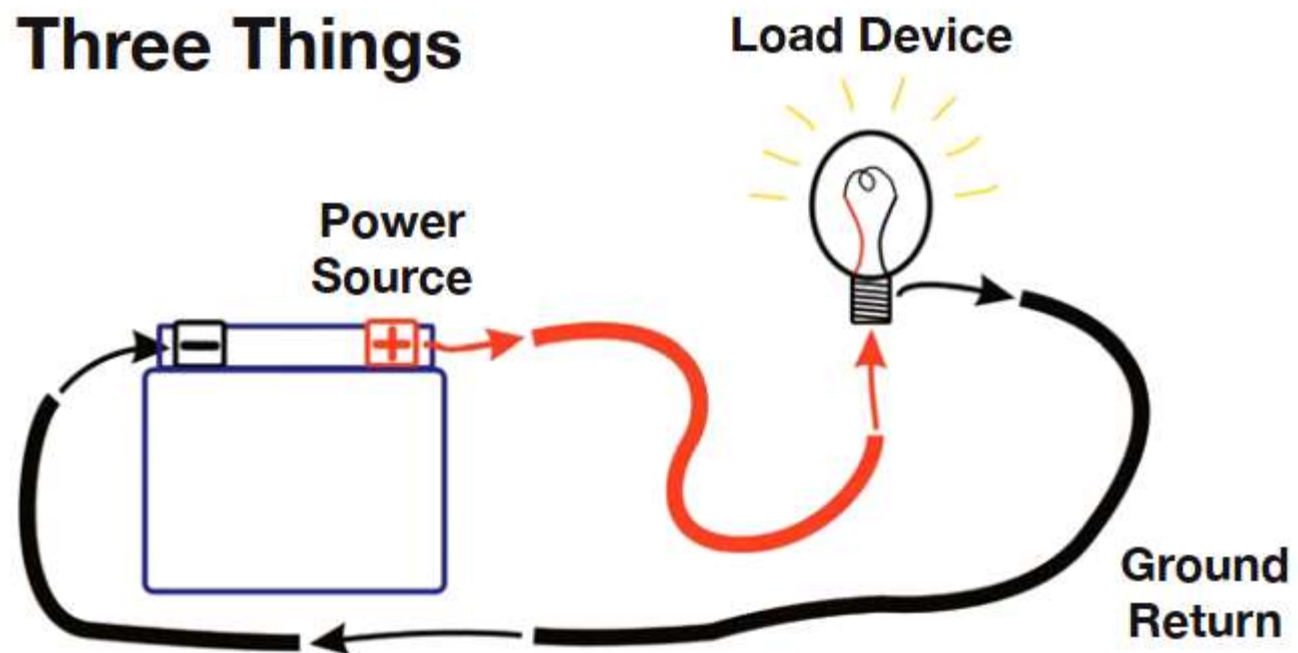


Inverting OPAMP

Wiring Diagrams



Three Things



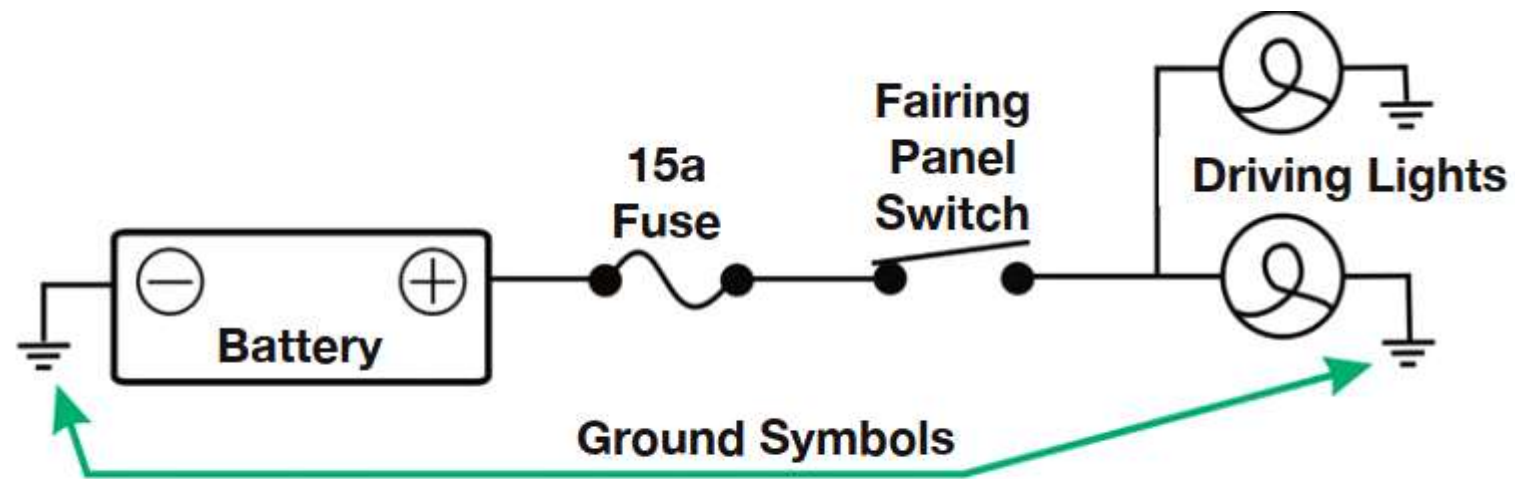


Fig 1: Simple wiring diagram of driving light circuit.

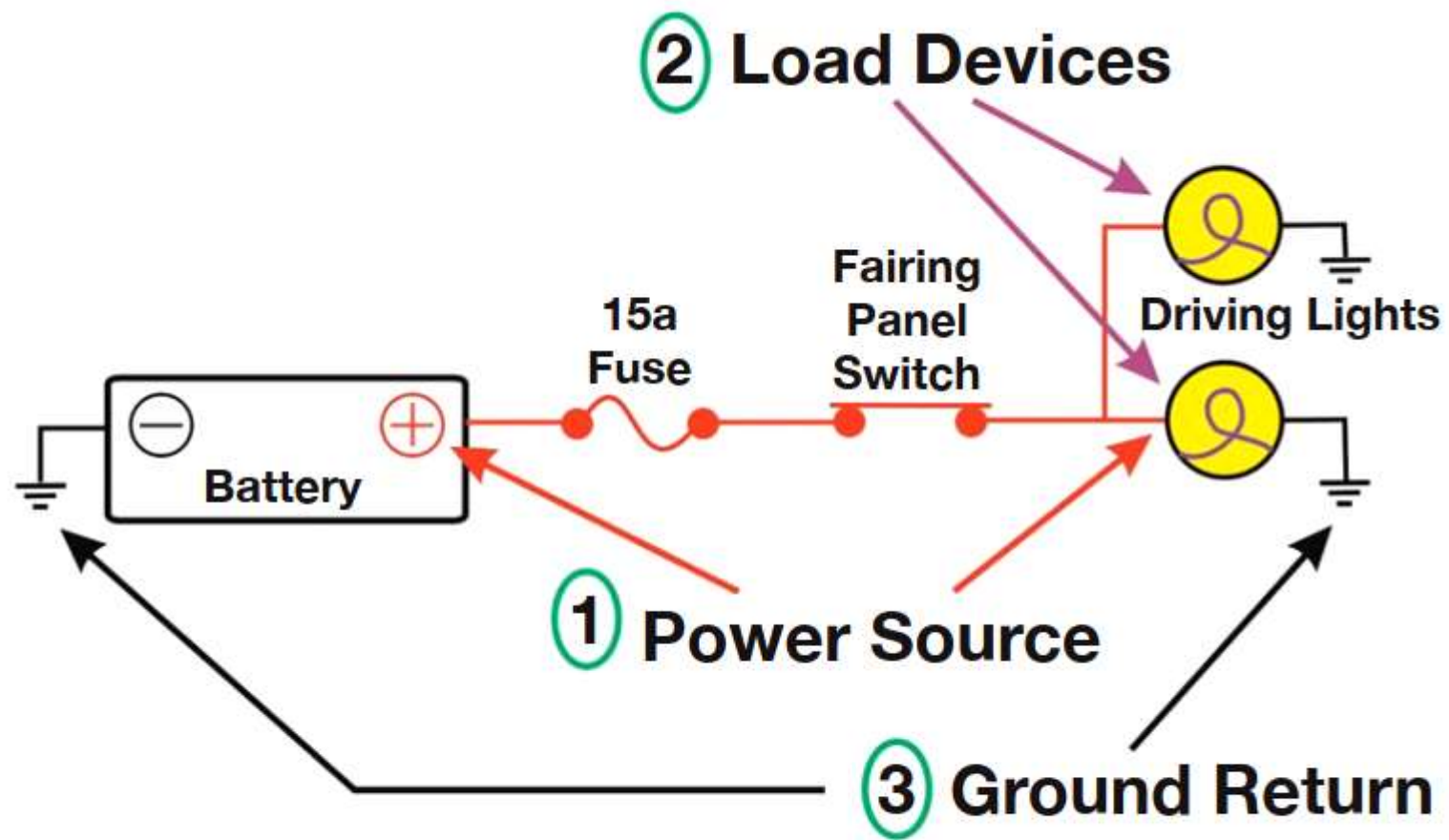


Fig 2: driving lights circuit in operation

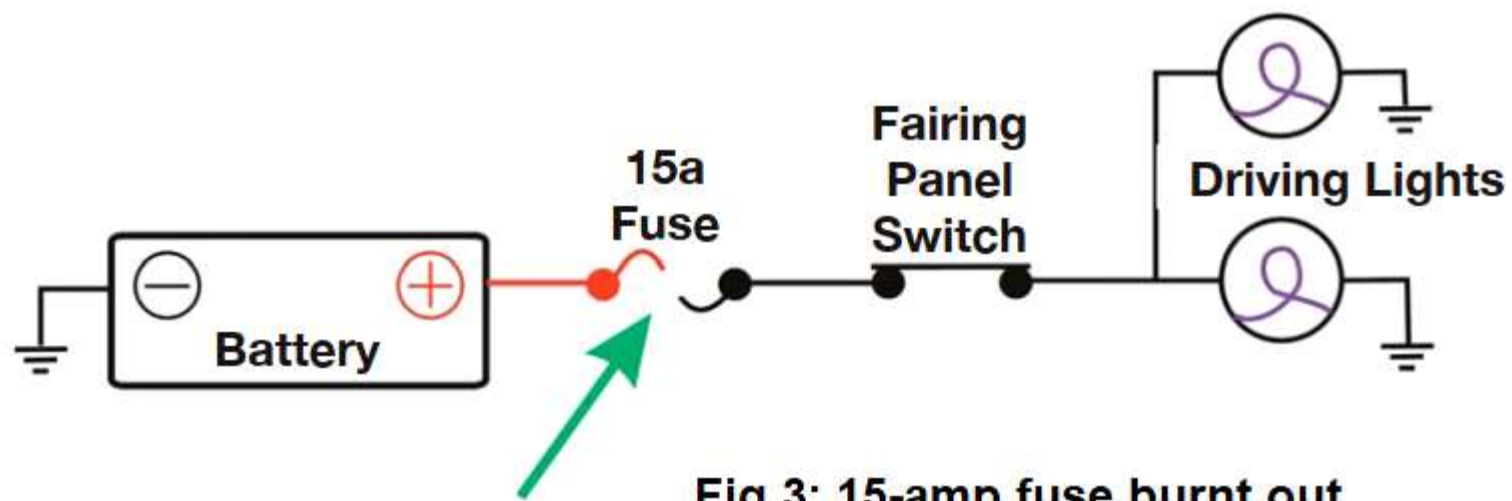


Fig 3: 15-amp fuse burnt out

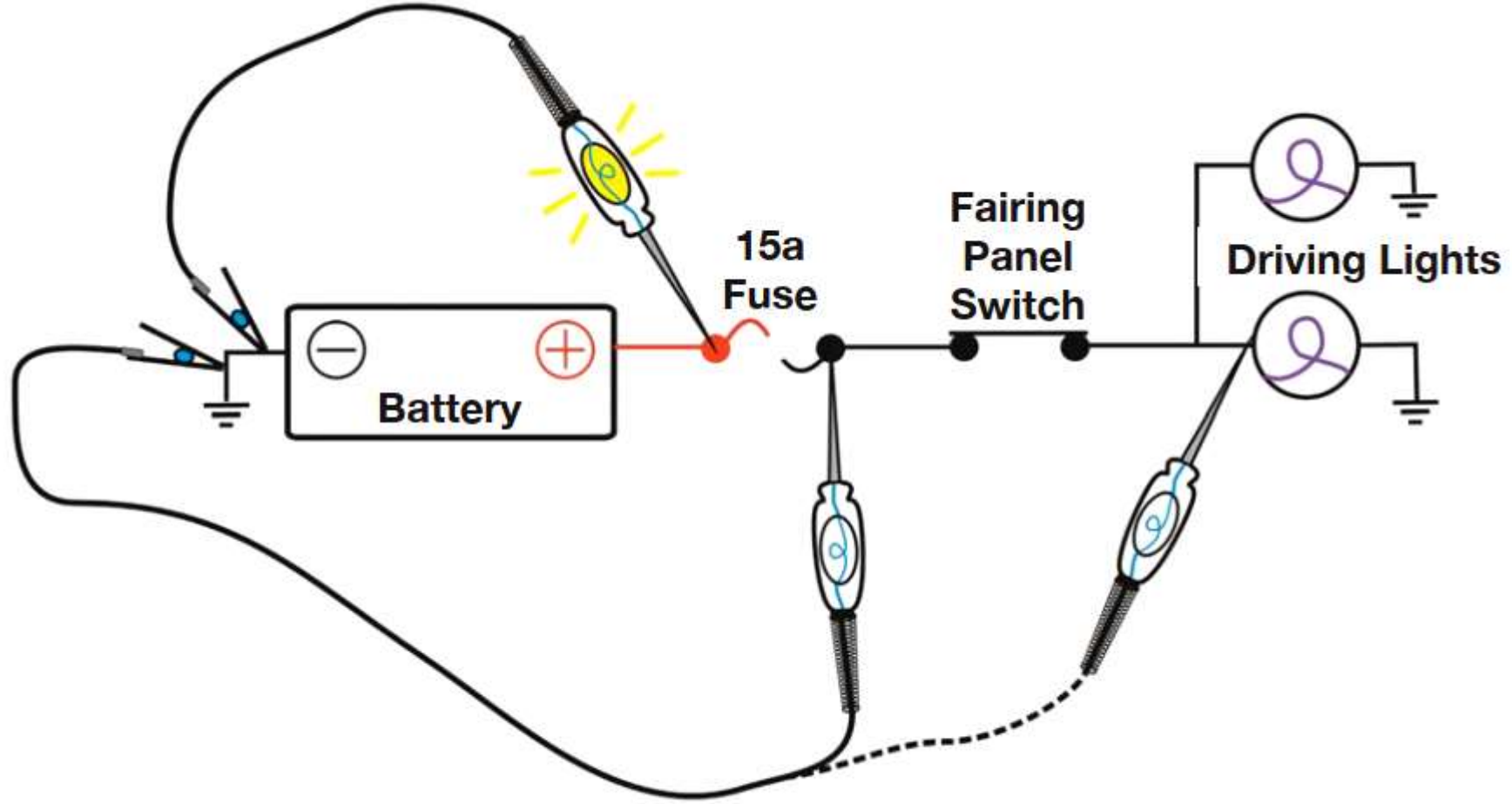


Fig 4: shows a test light connected to the negative battery termina

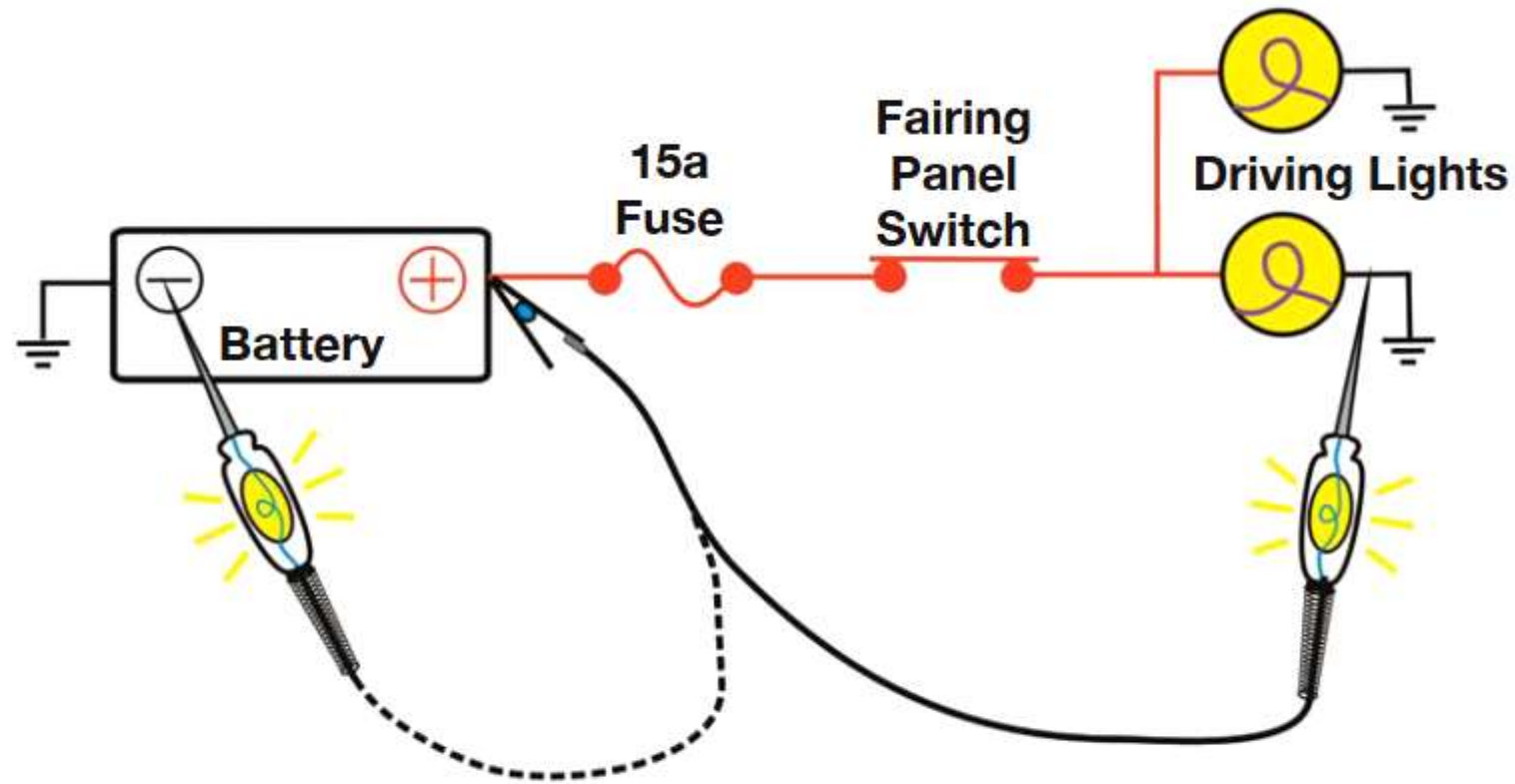


Fig 5: A test light connected to the positive battery terminal where it can be used to locate a break in the ground return side of a circuit.

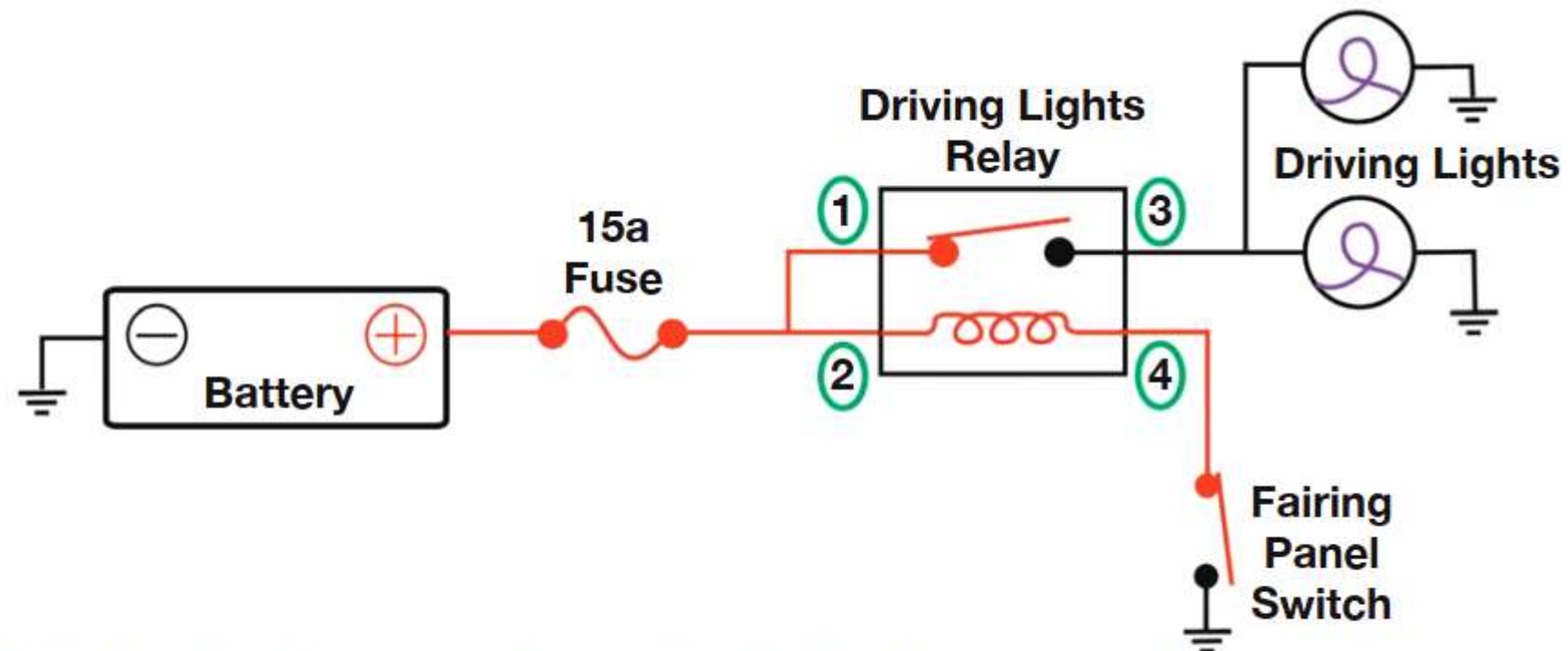


Fig 6: A relay has been added to the driving lights circuit.

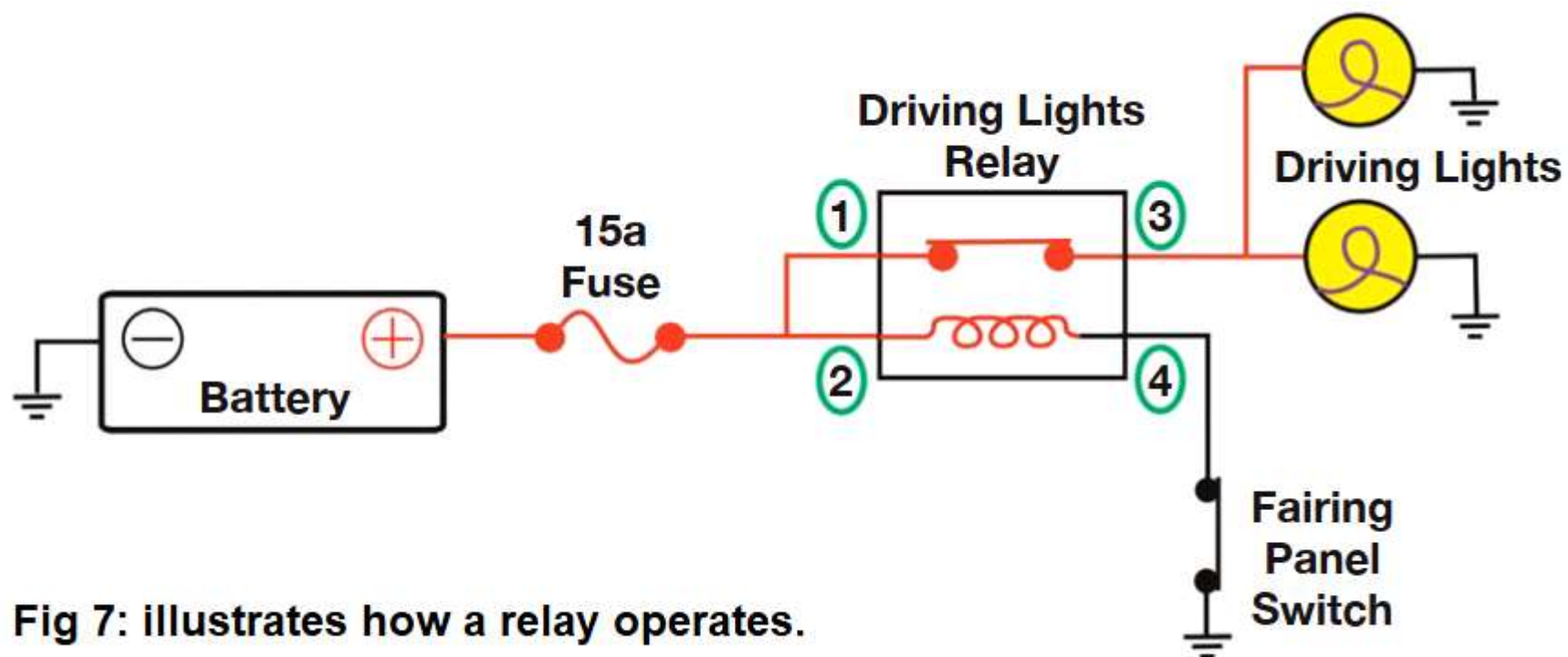
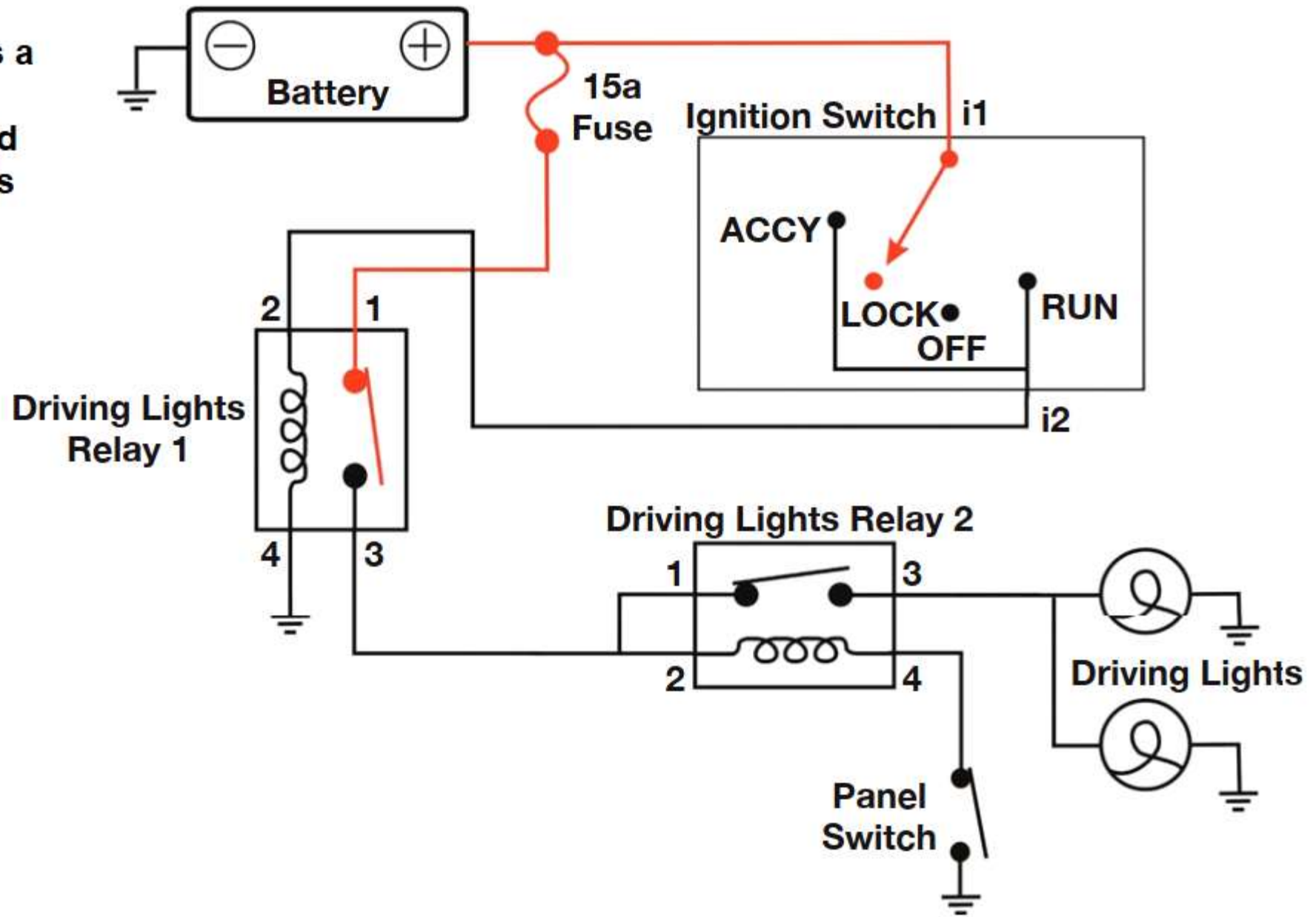


Fig 7: illustrates how a relay operates.

Fig 8: shows a more sophisticated driving lights circuit



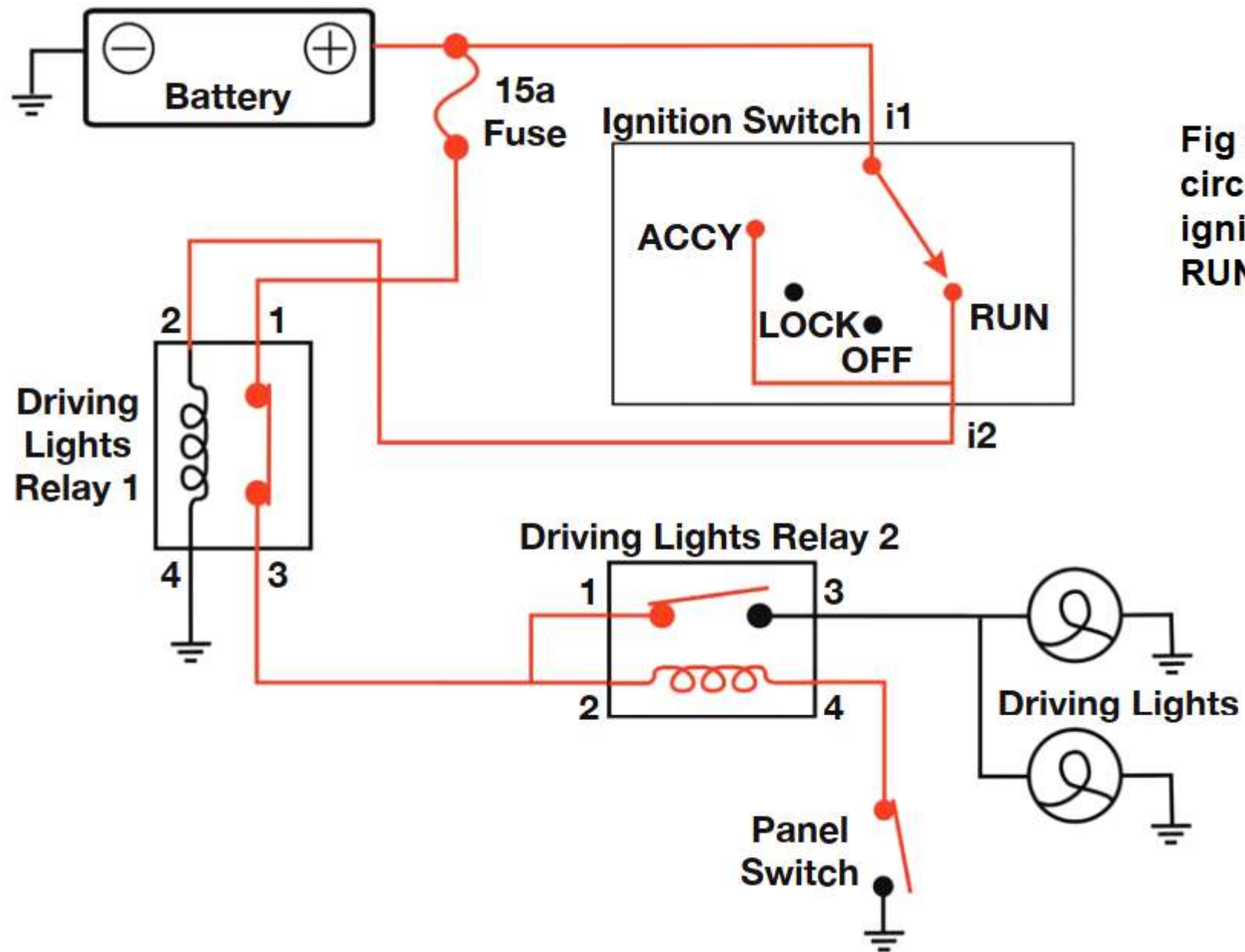


Fig 9: shows the circuit with the ignition key in the RUN position.

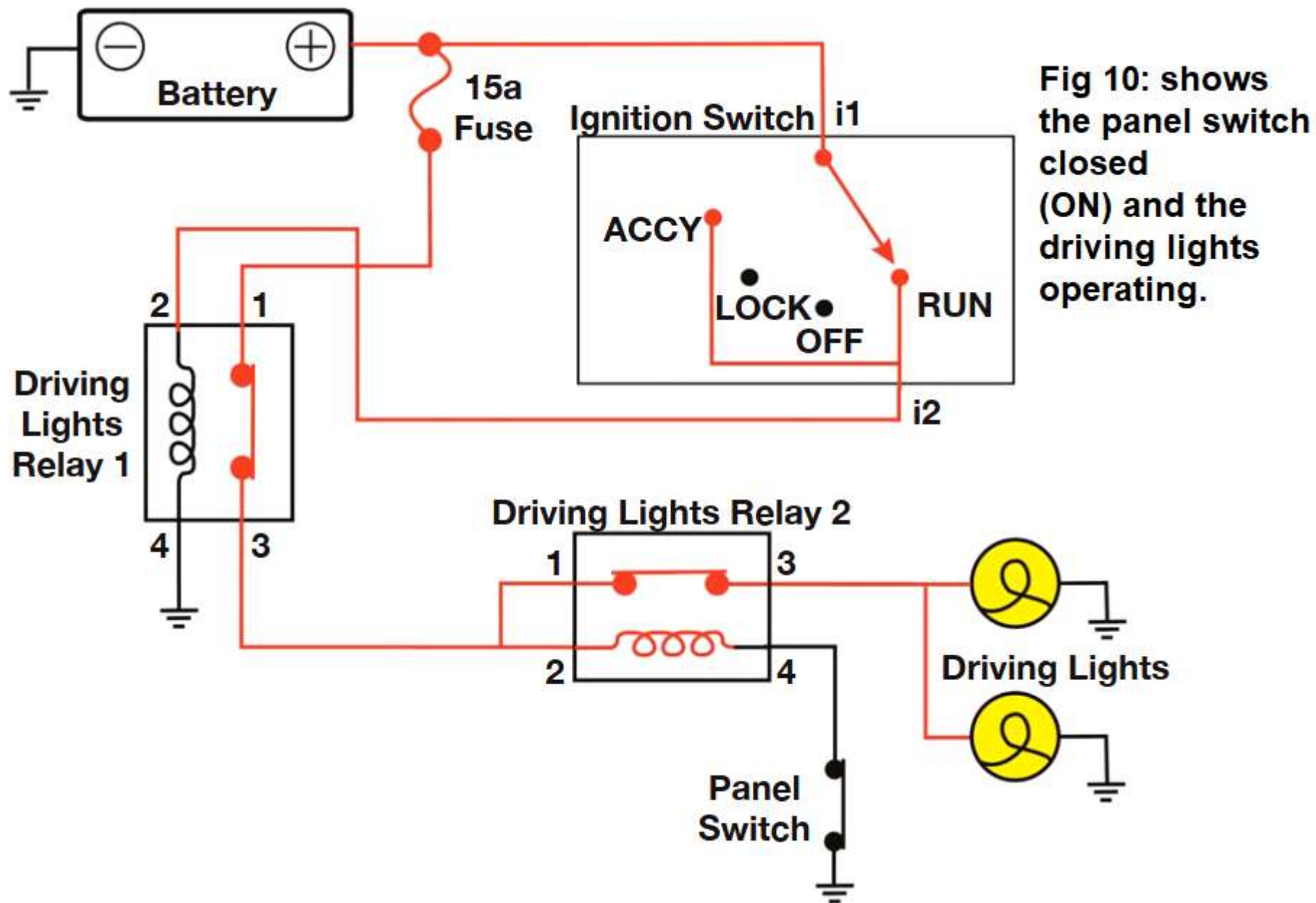
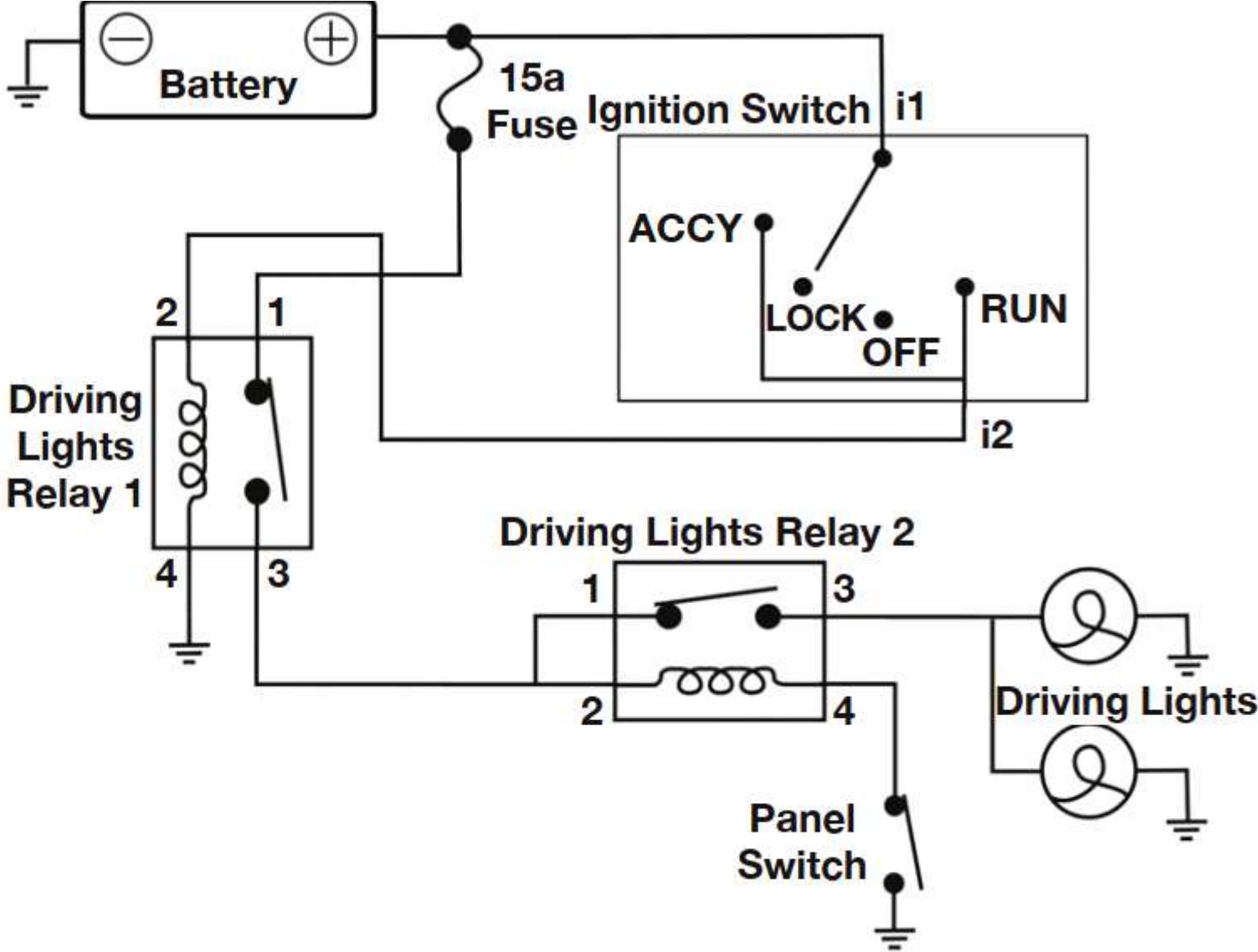
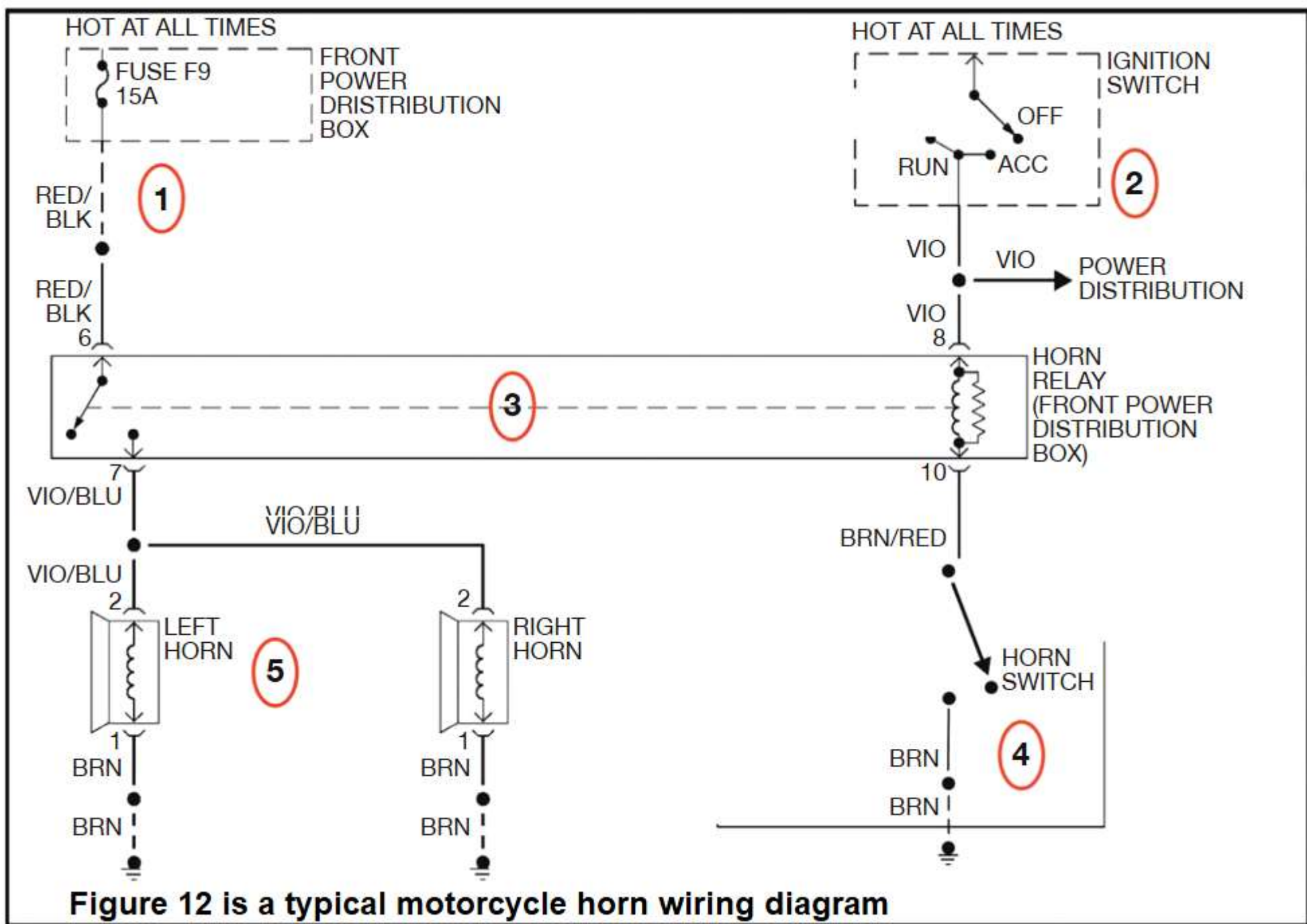


Fig 10: shows the panel switch closed (ON) and the driving lights operating.

Fig 11: is how the two-relay driving lights circuit would appear in a typical factory service manual.





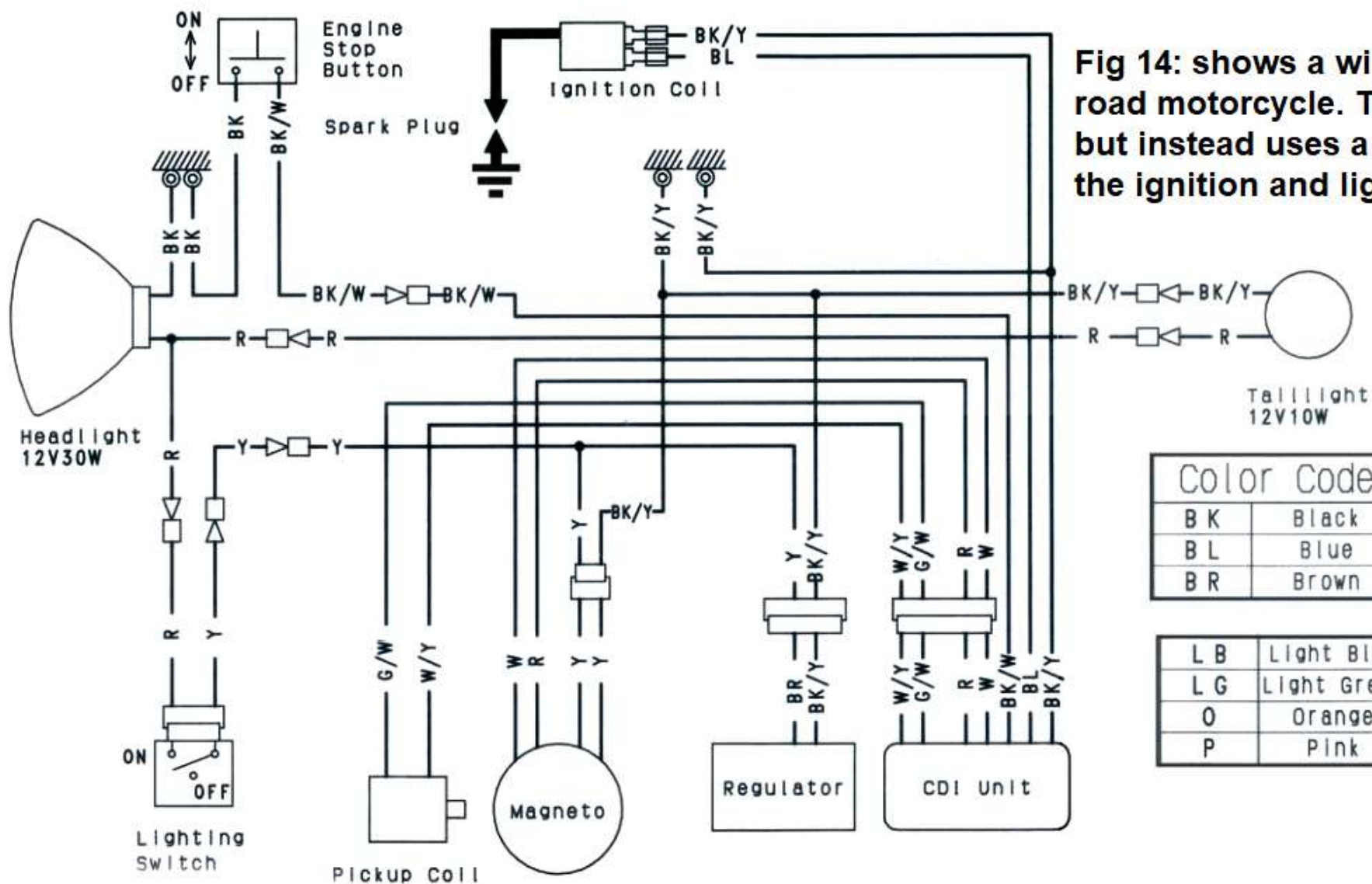


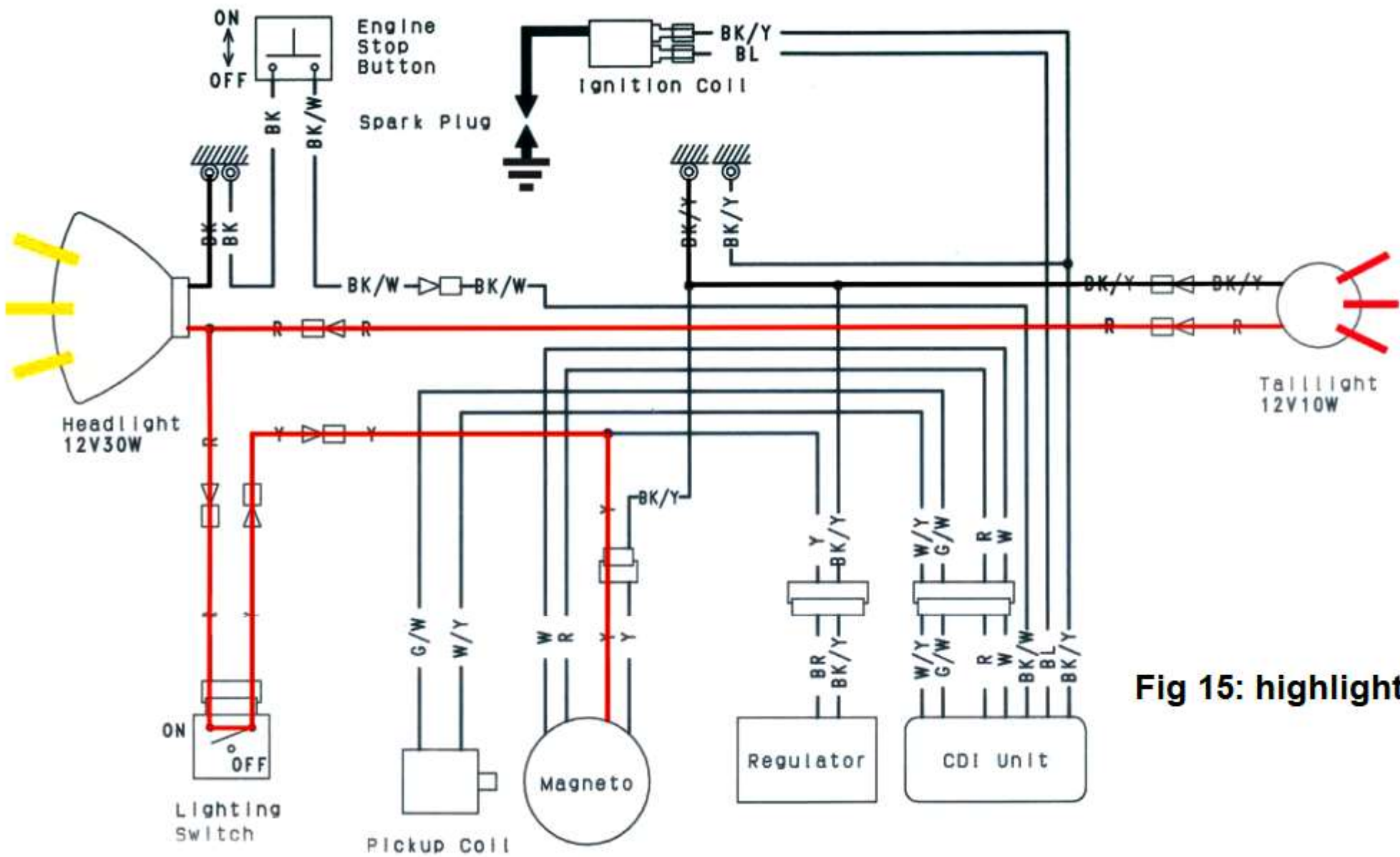
Fig 14: shows a wiring diagram typical for an off-road motorcycle. This bike does not have a battery, but instead uses a magneto as a power source for the ignition and lighting systems.

Color Code	
BK	Black
BL	Blue
BR	Brown

CH	Chocolate
DG	Dark Green
G	Green
GY	Gray

LB	Light Blue
LG	Light Green
O	Orange
P	Pink

PU	Purple
R	Red
W	White
Y	Yellow



Color Code	
B K	Black
B L	Blue
B R	Brown

C H	Chocolate
D G	Dark Green
G	Green
G Y	Gray

L B	Light Blue
L G	Light Green
O	Orange
P	Pink

P U	Purple
R	Red
W	White
Y	Yellow

Fig 15: highlights the lighting circuit.

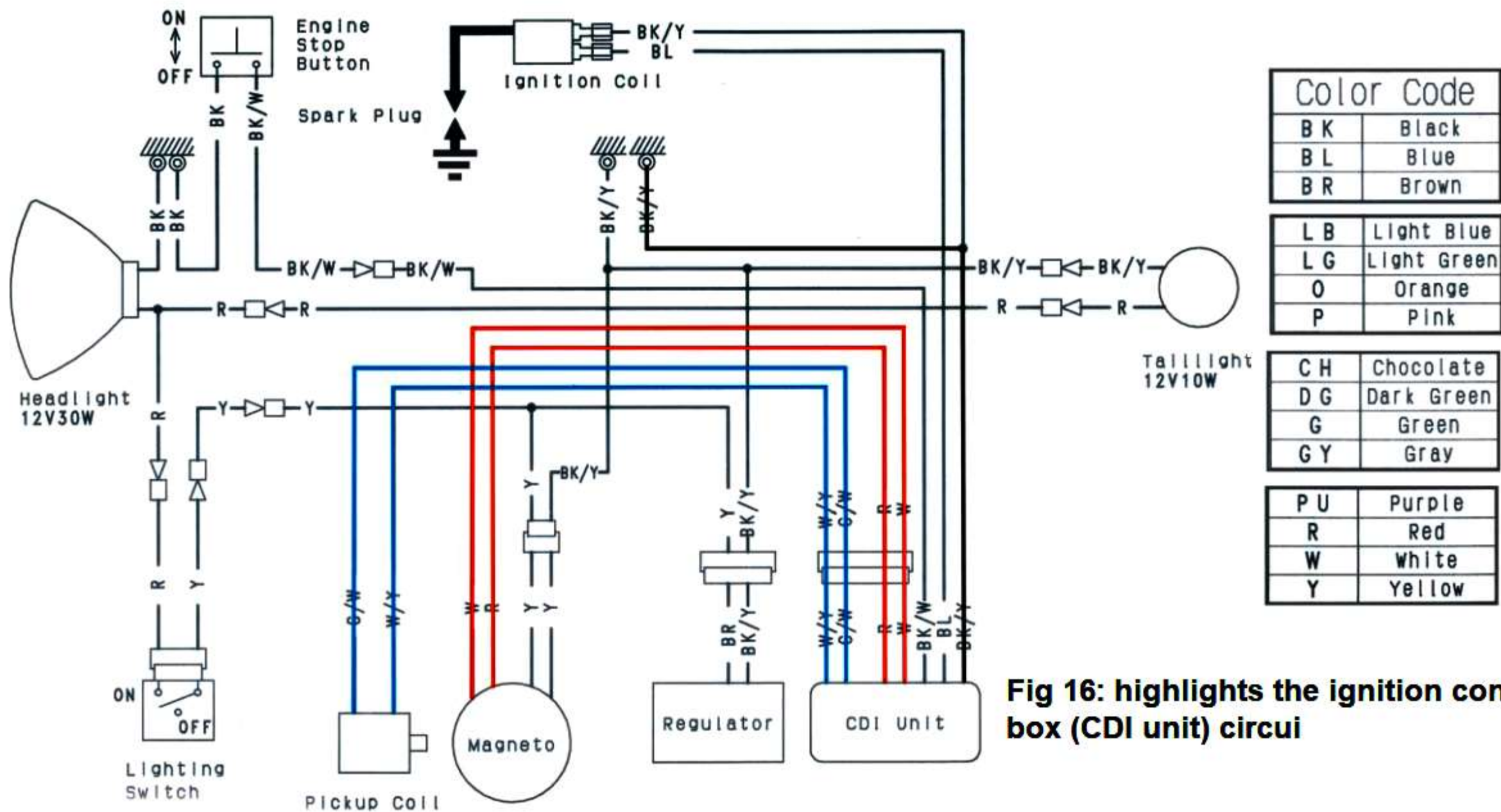


Fig 16: highlights the ignition control box (CDI unit) circuit

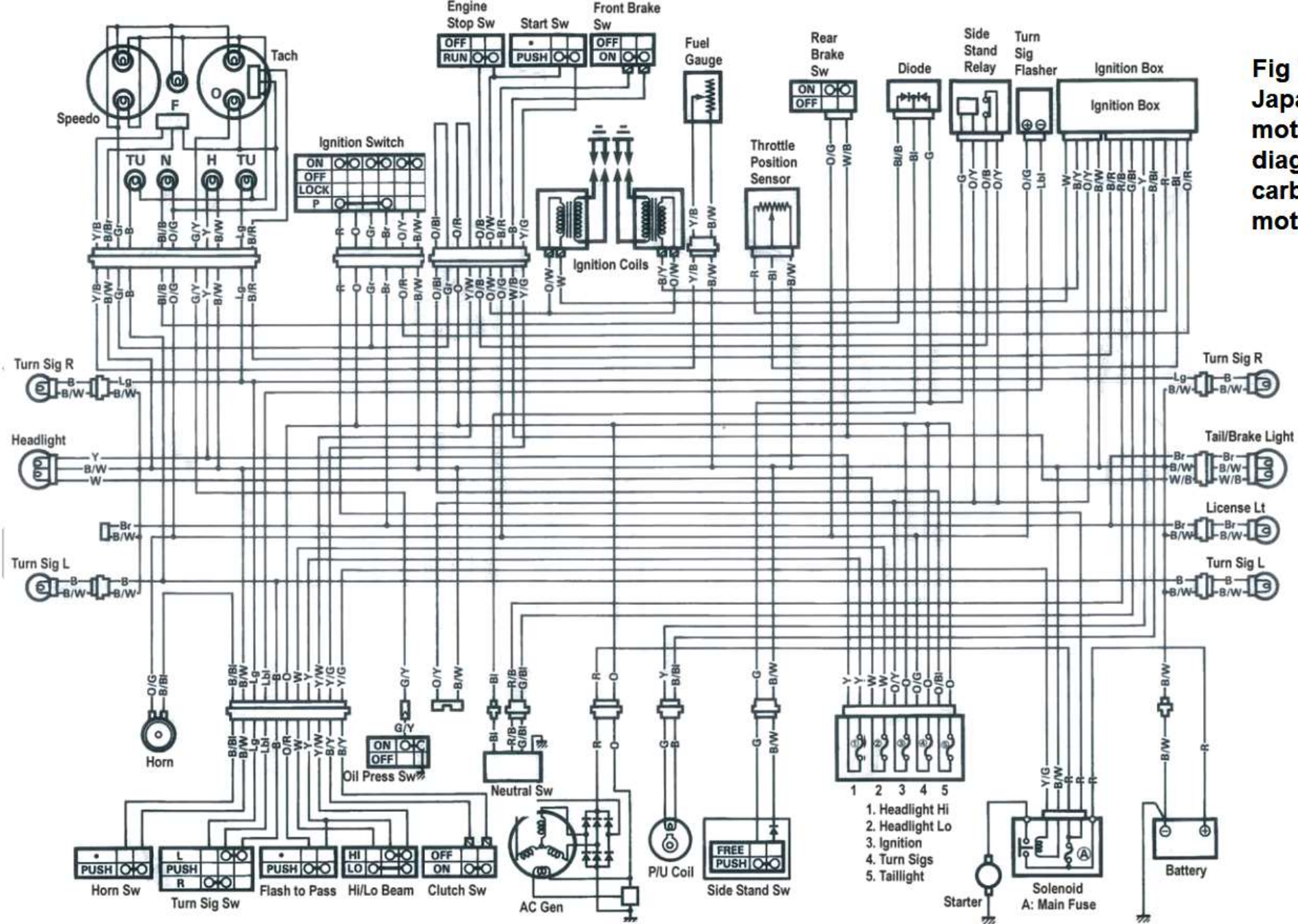
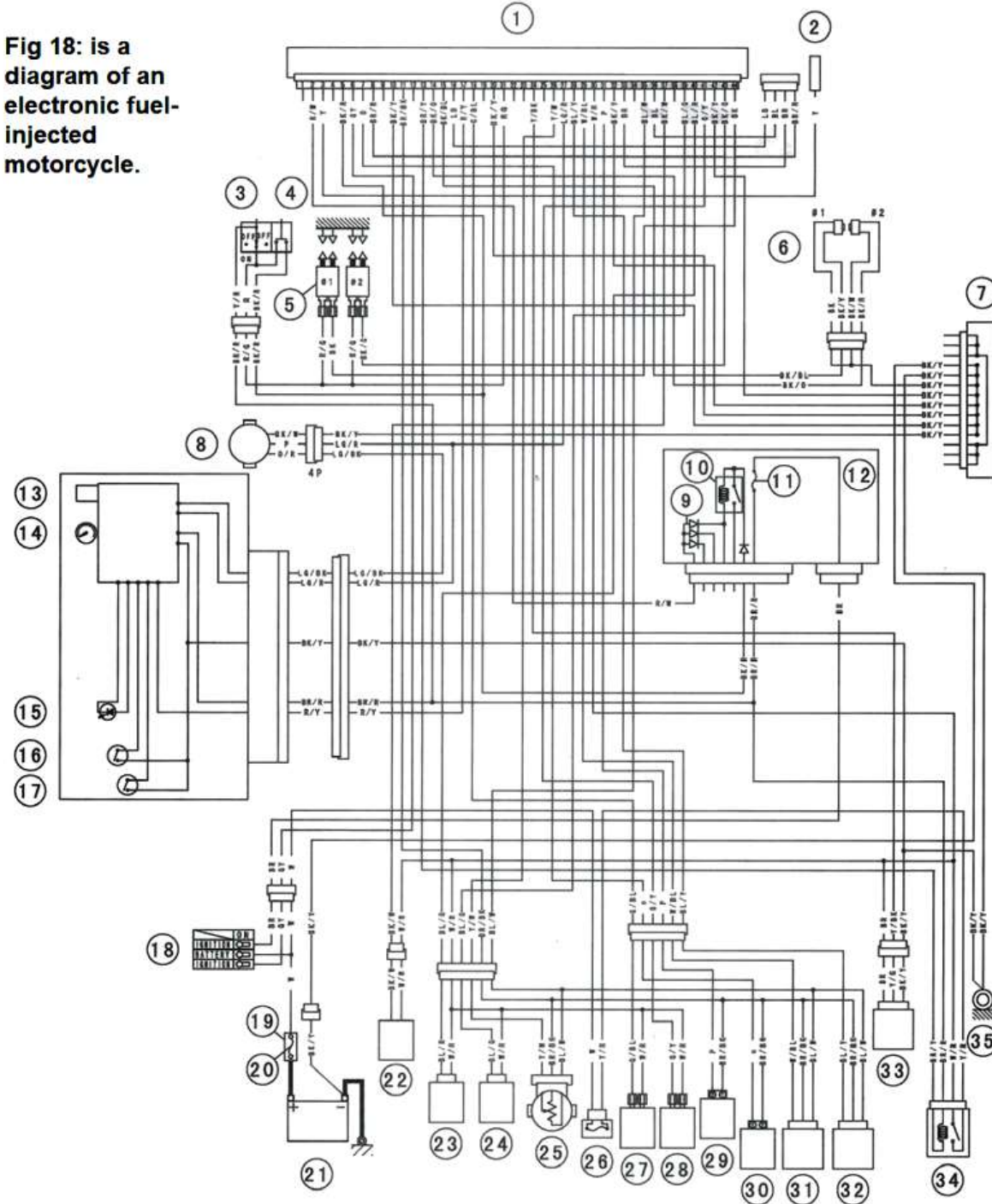


Fig 17: Typical Japanese motorcycle wiring diagram for a carbureted motorcycle

Fig 18: is a diagram of an electronic fuel-injected motorcycle.



Number	Component	Number	Component	Number	Component
1	ECM	13	Instruments	25	TPS
2	Diag Terminal	14	Speedometer	26	EFI Fuse
3	Eng Stop Sw	15	Check Eng Light	27	ISC Valve
4	Start Button	16	Mode Sw	28	ISC Valve
5	Ignition Coils	17	Reset Sw	29	Air Temp Sen
6	Crank Sensor	18	Ignition Switch	30	Eng Temp Sen
7	Connector	19	Starter Relay	31	MAP
8	Road Speed Sen	20	Main Fuse	32	BARO
9	Interlock Diodes	21	Battery	33	Crash Sensor
10	Start Relay	22	Fuel Pump	34	EFI Relay
11	Ignition Fuse	23	Injector	35	Ground
12	Junction Bx	24	Injector		

Fig 19 is the legend for Fig 18. Refer to this table to identify the components in the EFI wiring diagram

Motorcycle Engineering

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